

19th Annual RBM Vector Control Working Group Meeting

**Expanding the Vector Control Toolbox
is urgently needed and we should vote for it**

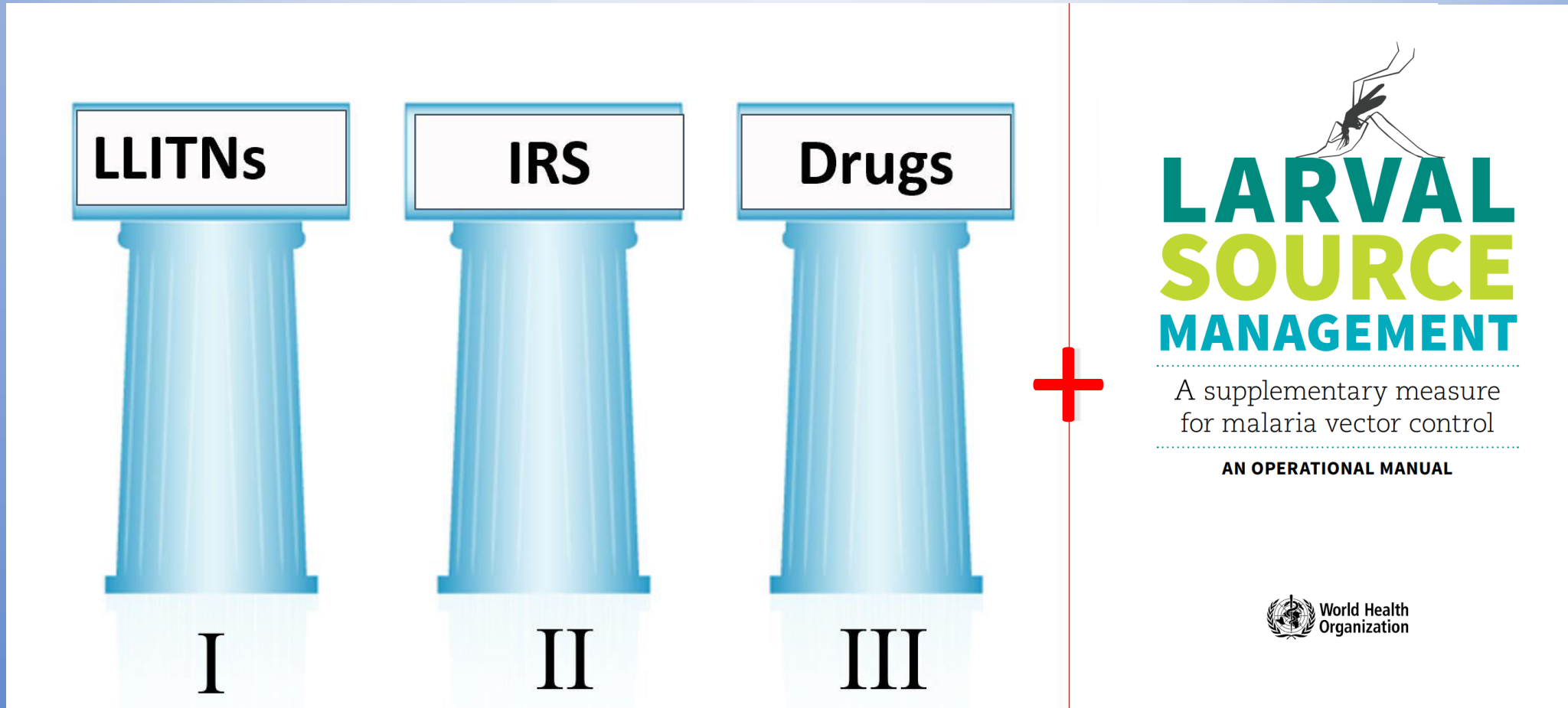
**William Gorgas, Fred Soper or Israel Kligler
pioneers of integrated mosquito control – their
legacy is as relevant as 100 years ago**

**Norbert Becker, Manuel Lluberas, Peter DeChant, Peter
Dambach and Rainer Sauerborn**

**Kigali
16th of April. 2024**

Our RBM-Working group initiated the preparation of an Operational Manual for Larval Source Management in 2012

as an additional tool to the three columns here (in blue) when ever it is feasible to apply



Golden Bullet?



There is no golden bullet in the fight against malaria - all available tools have to be used - larviciding has to go along with adulticiding whenever it is feasible.

Surprisingly in the **World Malaria Report**- to my understanding „LSM“ is **not mentioned with a single word!**

The **need for a more integrated control strategy including LSM** is underlined in the next slides

Are the achievements of the RBM Program after the Implementation in the year 2000 enough?

Year	No. of cases (in mill.)	No. decrease/increase in %	Death in thousands	Death -/+ in %
2000	243	100	864	100
2001	248	+2	873	+1.04
2002	245	+0.8	841	-2.7
2003	249	+2.5	813	-5.9
2004	250	+2.9	808	-6.5
2005	249	+2.5	770	-10.9
2006	244	+0.4	776	-10.2
2007	240	-1.2	754	-12.7
2008	239	-1.65	716	-17.1
2009	245	+0.8	726	-16
2010	247	+1.65	703	-18.6
2011	241	-0.8	665	-23
2012	237	-2.5	619	-28.4
2013	232	-4.5	591	-31.6
2014	230	-5.35	588	-31.9
2015	231	-4.9	586	-32.2
2016	232	-4.5	582	-32.6
2017	237	-2.5	580	-32.9
2018	232	-4.5	581	-32.8
2019	233	-4.1	576	-33.3
2020	244	+0.4	631	-27
2021	244	+0.4	610	-29.4
2022	249	+2.5	608	-29.6
2023	247	+1.65	625	-27.7

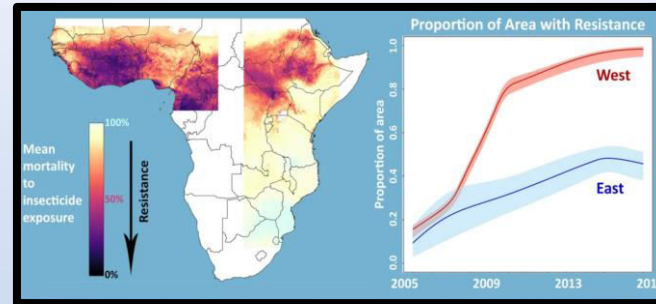
Despite all efforts (excluding LSM) and spending each year almost 3 billion dollars the number of malaria cases didn't decrease – but increased!

The positive result is that the number of death decreased by 30% the last decades!

What are the main reasons for the failure in the reduction of malaria cases?

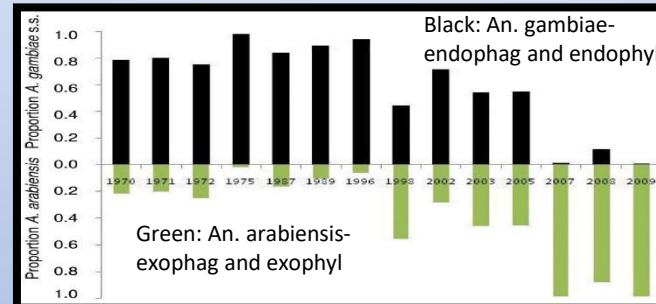
What are the challenges of the RBM-Malaria programme?

Pyrethroid Resistance of the vectors



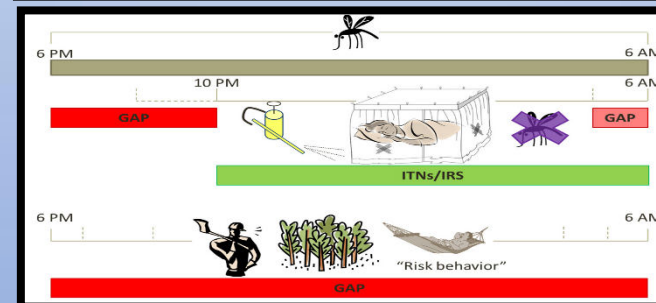
Deltamethrin Resistance in *Anopheles gambiae* s.l. mosquitoes in Africa is tremendously increasing (2005 – 2017)

Changing vector populations from endophagy (*An. gambiae*) to exophagy (*An. arabiensis*, *An. funestus*)



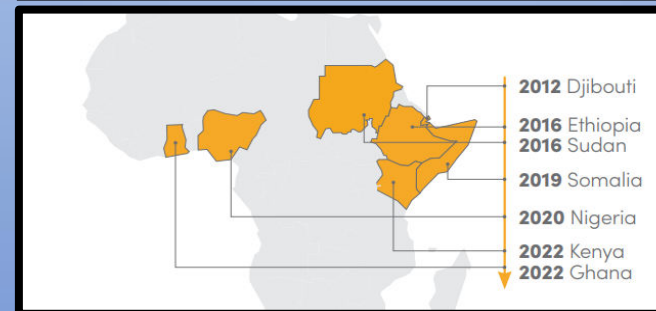
Shifts to exophagy due to non-uniform exposure to insecticides – selection pressure

„Protection Gap“ when only ITNs and IRS are applied



Gap: 6pm – 10 pm
Risk behavior – working and sleeping in field

Occurrence of new competent vectors: *An. stephensi*



An. stephensi spreads from 2012-2023 to 7 countries – dramatic increase of malaria cases in Djibouti

What is the lessons we have to learn?

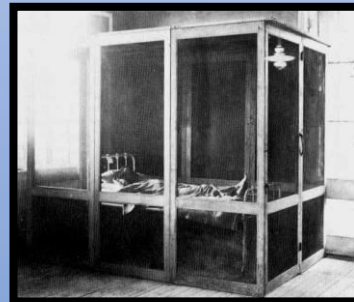
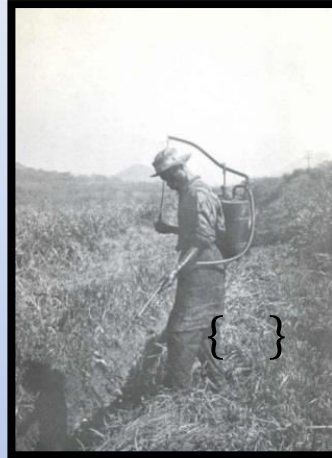
We have to **increase our tool box and should integrate LSM** whenever it is feasible and suitable to overcome the mentioned constraints.

In the following slides I give you a few **successful examples** of the successful implementation of LSM in integrated vector control programs.

Larval Source Management was a core-element in the Malaria and Yellow Fever eradication program in Panama



William C. Gorgas



First approach of integrated control based on:

1. *Drainage*
2. *Larviciding (oil)*
3. Prophylactic quinine
4. Screening
5. Adult killing

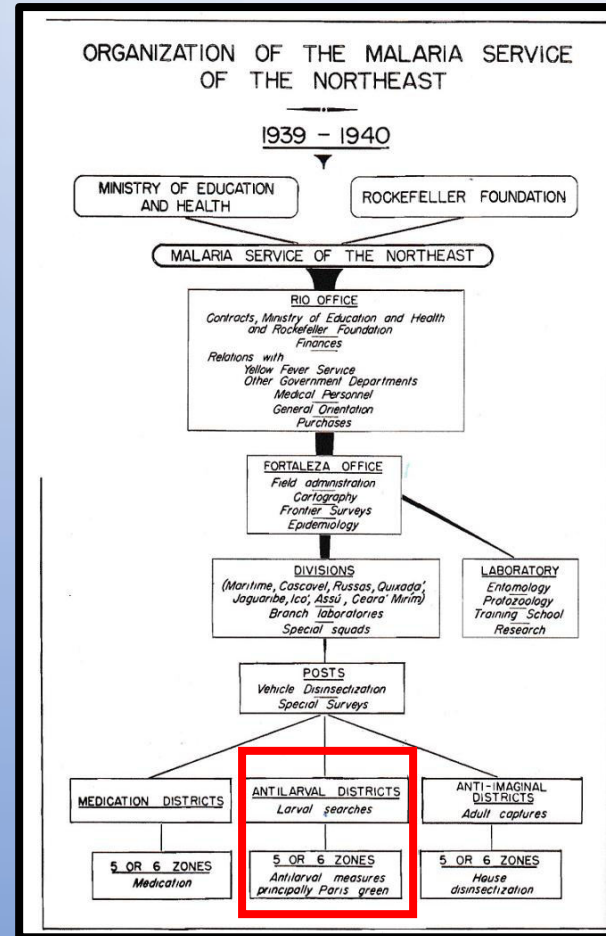
} LSM

By implementing **LSM** in Panama Gorgas he made the **construction of the Panama channel possible** – he became a **National hero!**

Larval Source Management was a core-element in the malaria eradication program in Brasil



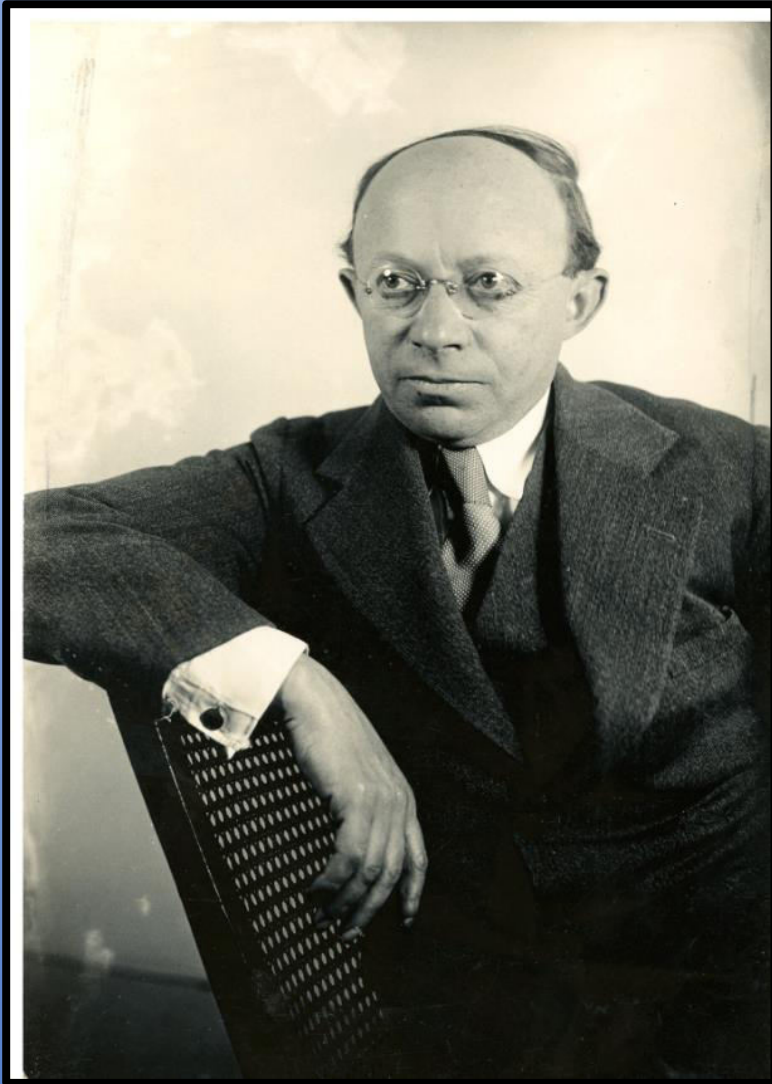
Frederick Sober



to a place of minor importance. After several disappointing months of intensive organization, the Malaria Service began a heavy attack with Paris green and pyrethrum spray insecticide on gambiae in both larval and adult forms, and initially concentrated its efforts on the peripheral and frontier zones. Gambiae was stopped in its career of invasion, was beaten back, and finally eradicated from the known infested area in less than two years' time. Observations covering a period of a year and a half, including two rainy seasons, after the suspension of all antigambiae measures, indicate that eradication has been complete. Precautions must be taken to

Frederick Sober eradicated *An. gambiae* from Northeast Brazil from 1939 – 1940 by **Larval Source management** with Paris green (arsenic based insecticide) and pyrethrum spraying.

Kligler's Anti-malaria campaign through LSM resulted in the eradication of malaria 100 years ago in Palastine



Israel Jakob Kligler



His success to eradicate malaria was based on **LSM** - making potential breeding sites non-productive for mosquitoes by

- ***mapping and drainage of the breeding sites,***
- using ***larvivorous fish*** (*Gambusia* sp.) and
- ***community participation*** by educational programs.

The German Mosquito Control Programme

a story of success *solely based on LSM* employing formulations of *Bacillus thuringiensis israelensis* and **water management** in a community-based program to combat floodwater mosquitoes



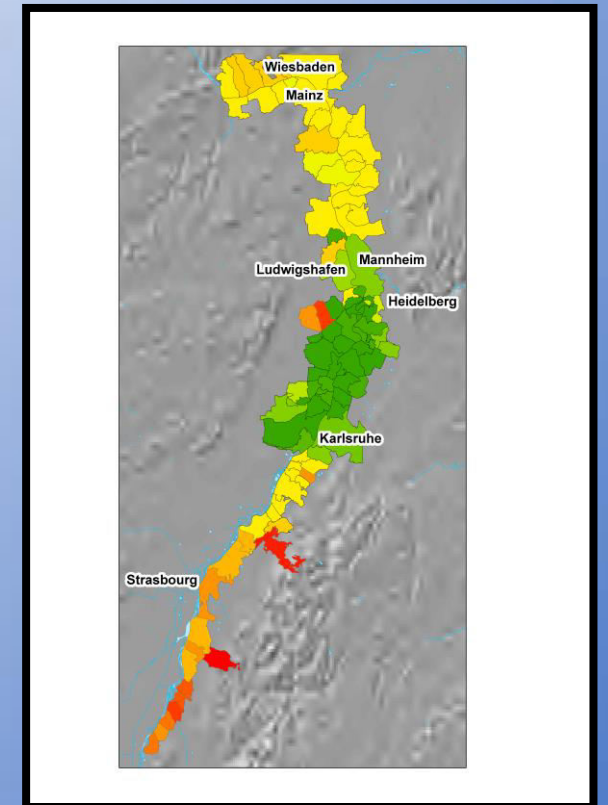
Members: Communities/Cities/counties: 95

Inhabitants:	3 Million
Control Area:	6.000 km ²
Breeding area:	60.000 Hectars
Number of sites	6.000
Permanent Staff:	60
Temporary staff	200

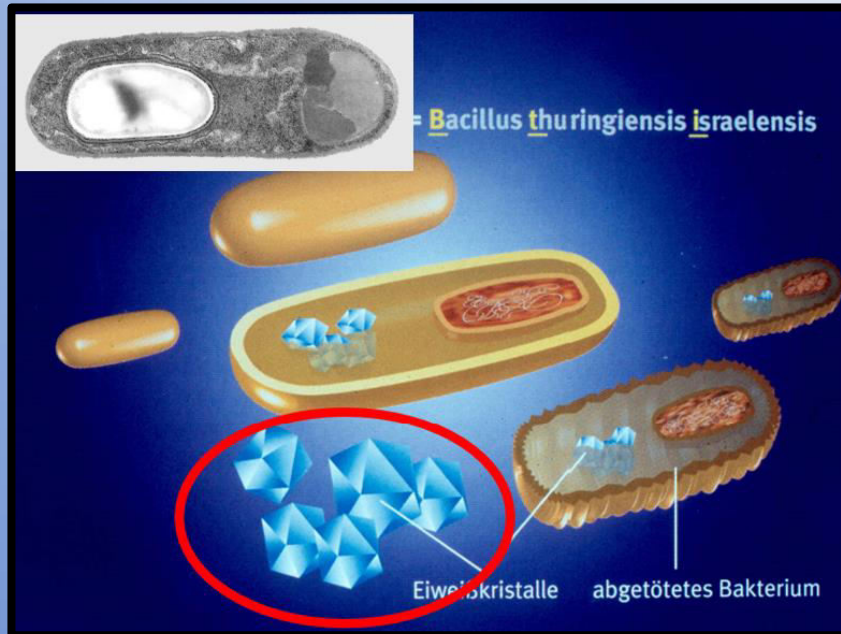
Budget: appr. 6.5 Mill. Euro

Average costs: **appr. 2,6 €/caput/Year**

What are the reasons related to the success of this program!



The break-through was the implementation of *LSM* based on the use of formulations of *Bacillus thuringiensis israelensis* and water management



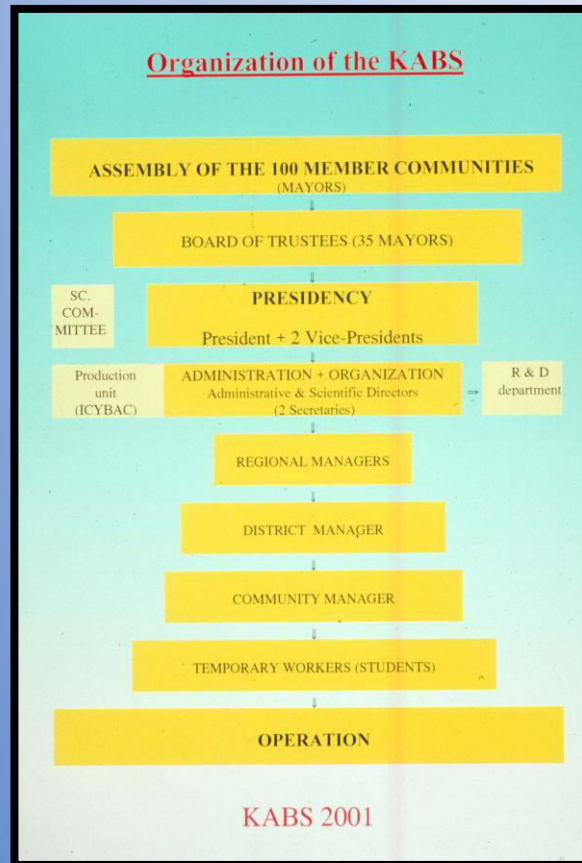
Protein toxins of the soil-bacterium *Bacillus thuringiensis israelensis* are **extremely selective** – kill only larvae of some nematoceren flies as mosquitoes and blackflies. Keeps the **biodiversity**, Easy to handle – and are **not toxic for the user!**



Water management to modify the breeding sites to be not productive for mosquitoes and **encouraging** of the major larval predators – the **FISH**.

Prerequisites for a successful LSM programme in an integrated strategy

Political will!



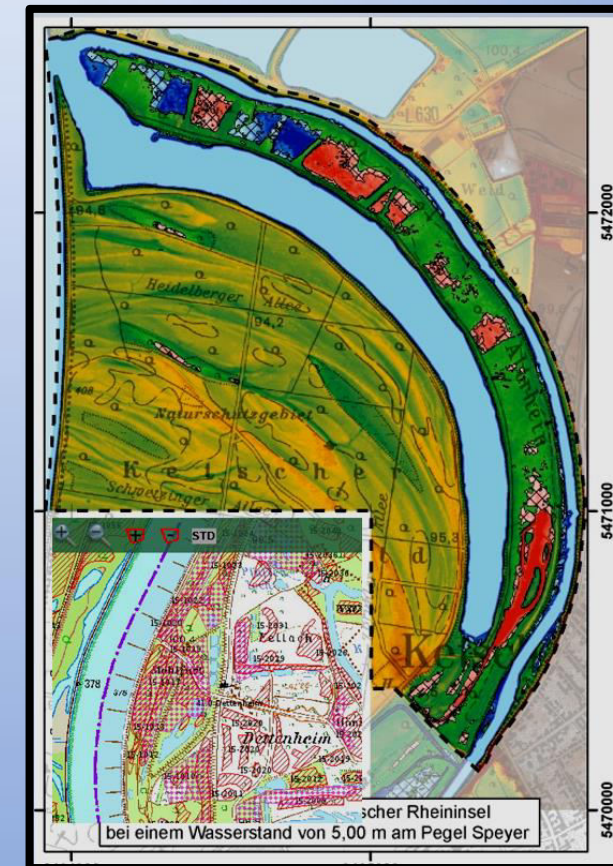
**Functioning Infrastructure on
a community-base!**

Clear responsibilities



**Training of staff in biology of
vectors, handling of
insecticides and operation**

Precise Mapping



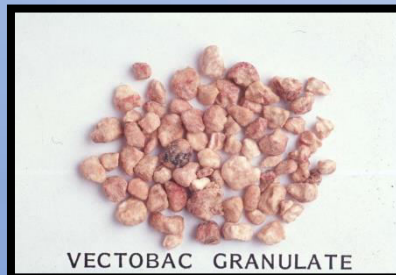
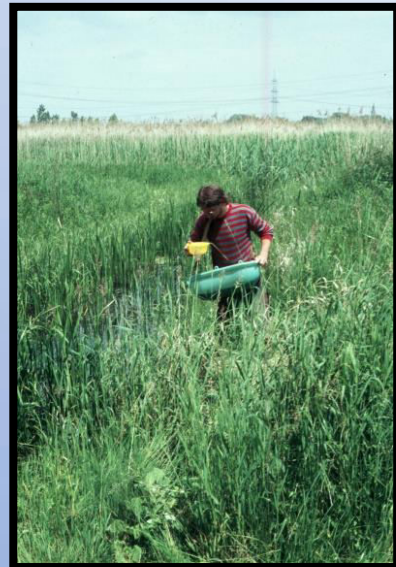
**Mapping and numbering of
the breeding sites for quick
communication.**

We have suitable Formulations and Application techniques to our disposal for...

Ground Application

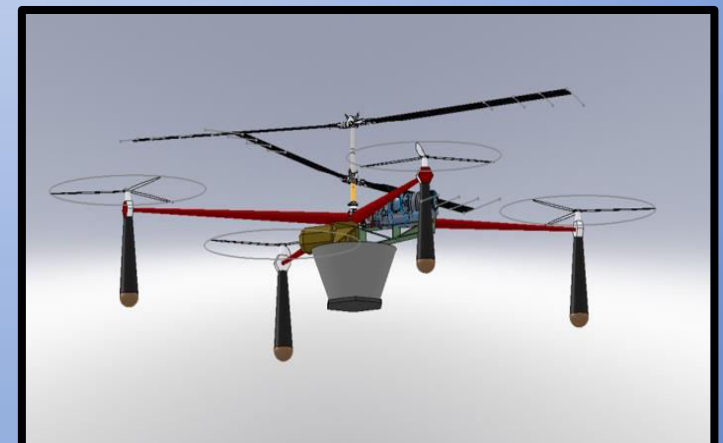


**Knapsack sprayers
500g Vectobac WG in
10 Liter of water/ha**



**BTI- corn cob granule
5-10 kg/ha**

Aerial Application



Helicopters and drones allow precise wide-scale application when abundant floodings occur.

Summary of the LSM-activities with Bti in the Upper Rhine Valley the last 40 years

Consumption of Bti from 1981-2020 > 5000 tons

Granules: 5.086 tons

Powder/Fluid concentrates: 86 tons

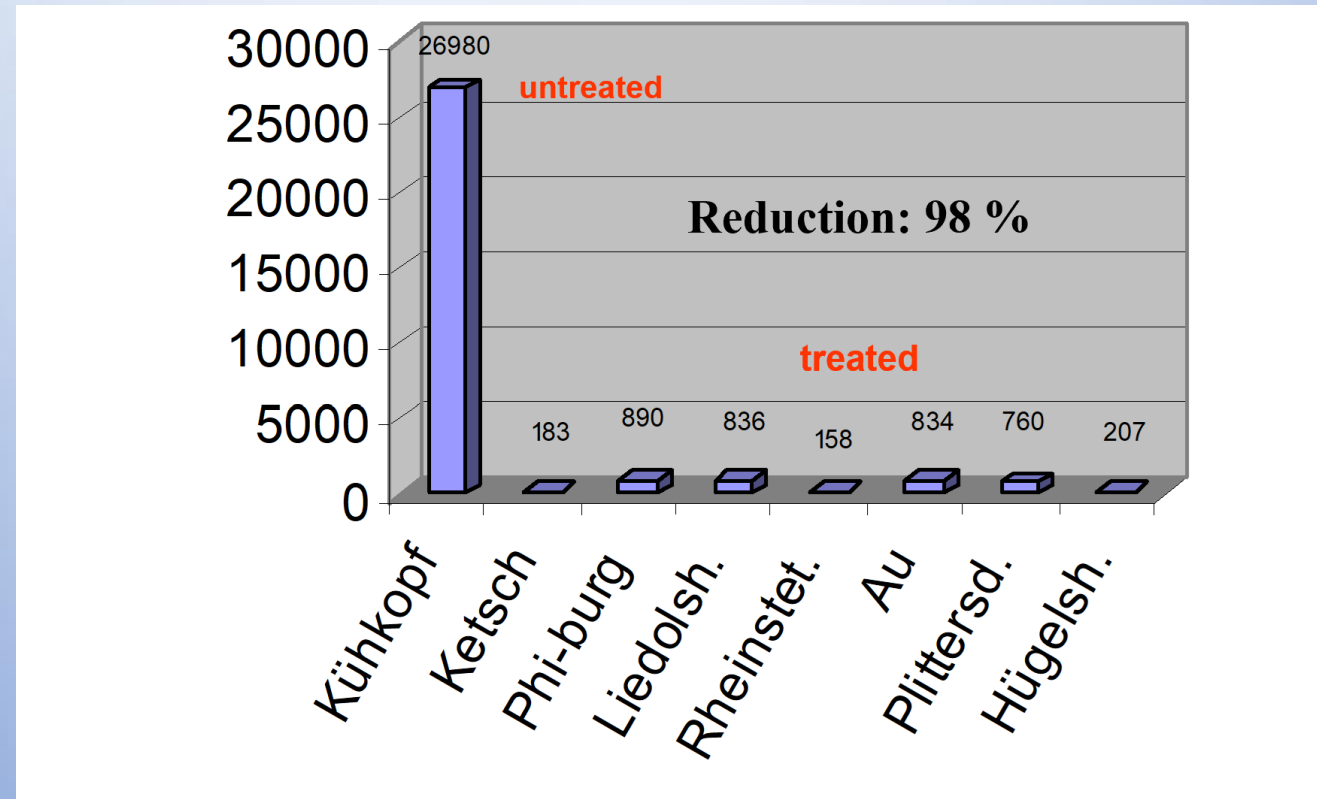
Treated areas from 1981-2020 > 420.000 hectares

Total area: 423.998 Hectars

Helicopter applications: 274.668 hectares

Ground application: 149.330 hectares

Result of all LSM activities: >95 % Reduction of the floodwater mosquitoes



Before control



After control

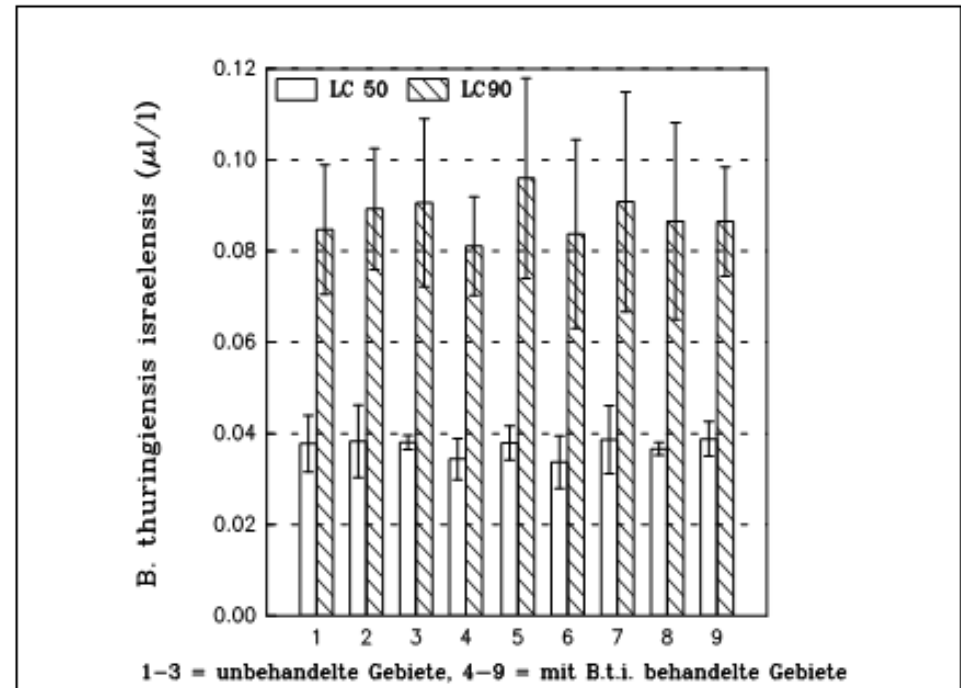
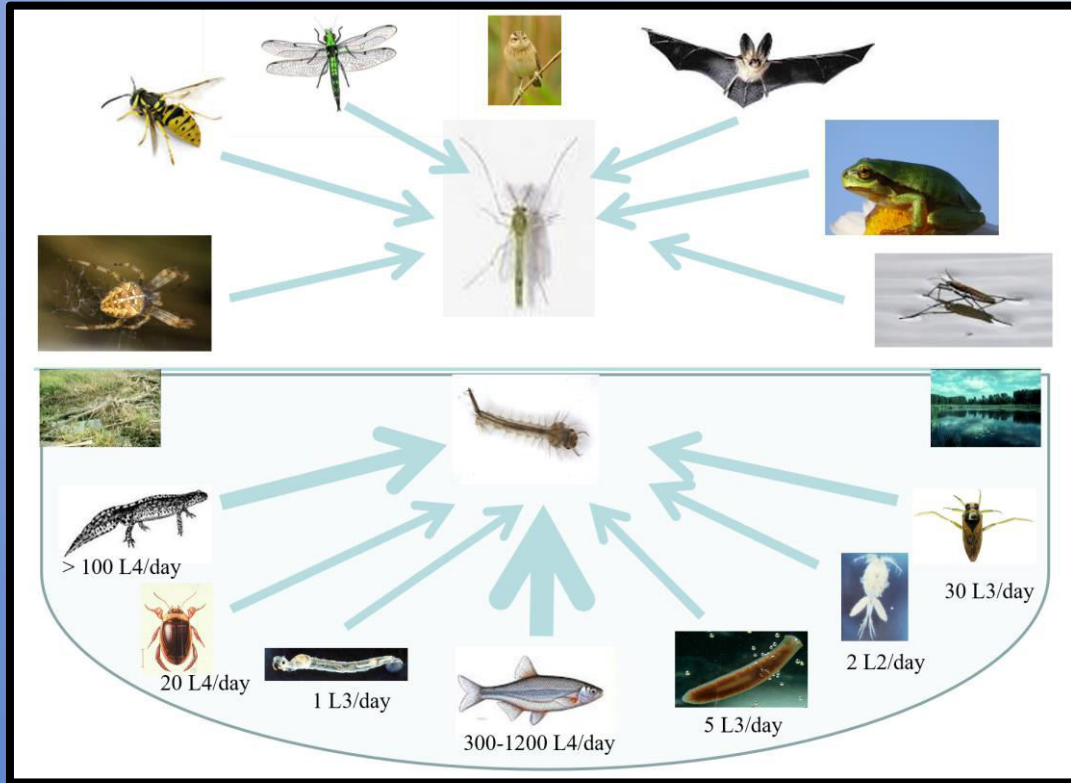
Employing CO₂-baited EVS-traps in regular intervals for quality control.

The Public appreciates the results with great enthusiasm – increase of life quality!

Remarkable Side-effects of LSM with Bti

Conservation of the biodiversity

No resistance after 40 years!





Bridging from the Upper Rhine to the Sahel zone in Burkina Faso

The EMIRA Project



(ecological malaria reduction in Africa by LSM)

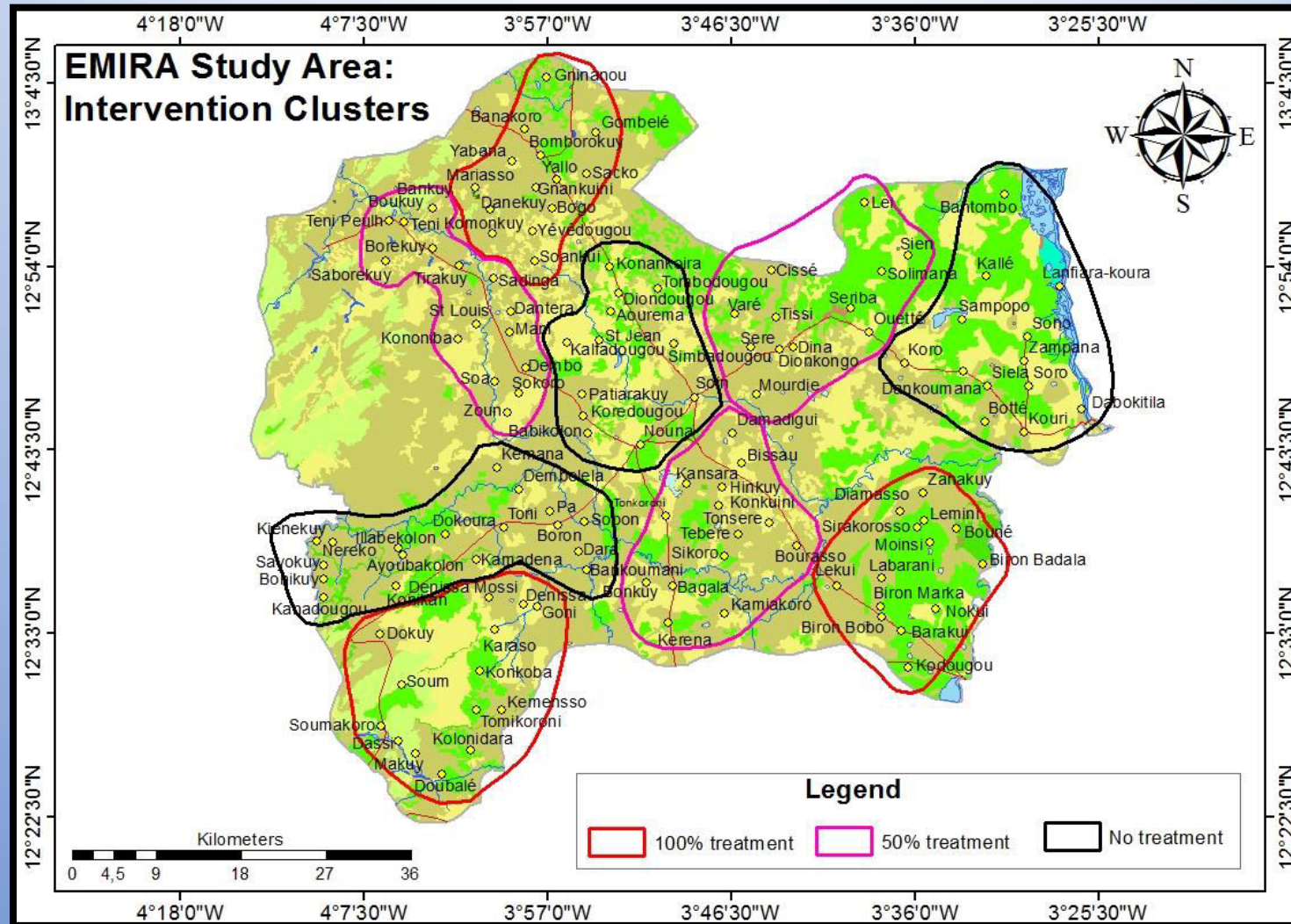
A cooperative programme between the Health Department in Nouna, Province of Kossi, Burkina Faso, the University of Heidelberg and the German Mosquito Control Programme (KABS)

Financed by the Foundation of Manfred Lautenschläger (appr. 400.000 Euros)

The Provinz Kossi has ca. 230.000 inhabitants; Capital city „Nouna“: 25.000 inhabitants.



Intervention area in the Province of Kossi

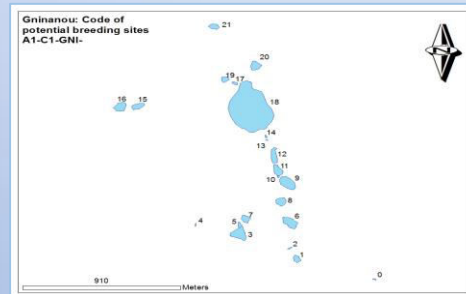


Altogether **84 villages** (red) were treated with Bti and 43 villages (black) served as control

Building the infrastructure

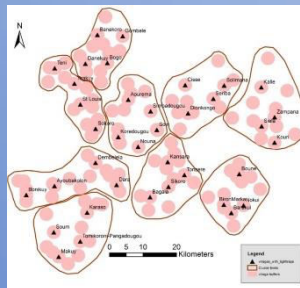
In the Preparation phase (2013) for the Intervention phase (2014-2015)

Mapping of the breeding sites and assessement of the optimum dosage of Vectobac WG (2013)



For each village maps are prepared (GPS-codes) for quick and precise intervention.

- Entomological and Epidemiological Assessments (2013-2015)



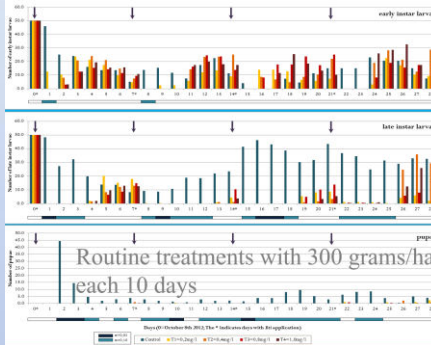
In each cluster 4 villages and in each 3 houses have been monitored by CDC traps bi-weekly



Epidemiological Data collected from the Health Center in Nouna

Assessment of the optimal dosage and Capacity building

- **Assessment of the optimal dosage (2013)**



Tested product: Vectobac WDG (3000 ITU/mg)

Result: **300 g/ha each 10 days.**

- **Capacity building and development of the community-infrastructure**

Selection of spray personal (each village 1 spray team with each two people) = 160 people

Quality control: 20 controllers check the accuracy of the treatments

Sensitization of the villagers



Governmental application, close cooperation of all relevant authorities (ministries, health departments, institutions) was important

Training of the 180 field workers



Training in the health center
in Nouna

Project manager is:
Dr Issouf Traore and Dr Peter
Dambach

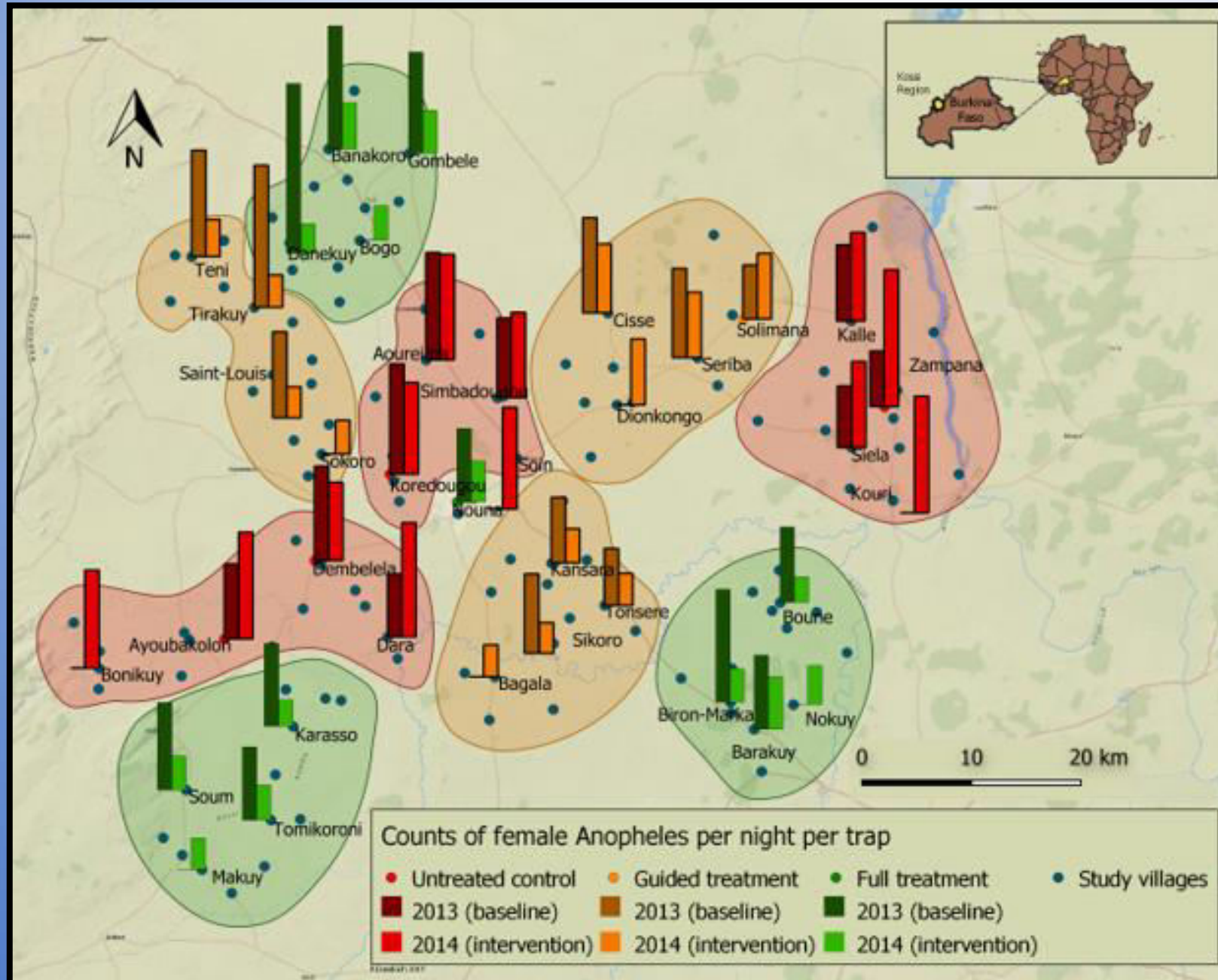


Bti- Intervention 2014 - 2015



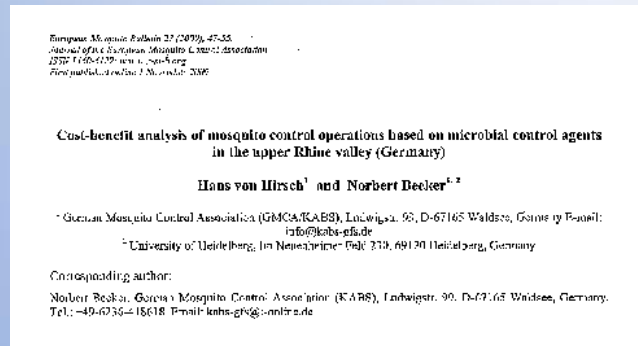
Application in Nouna is as successful as in the Upper Rhine Valley with an appropriate infrastructure on both sides.

Counts of *Anopheles* females per night per trap

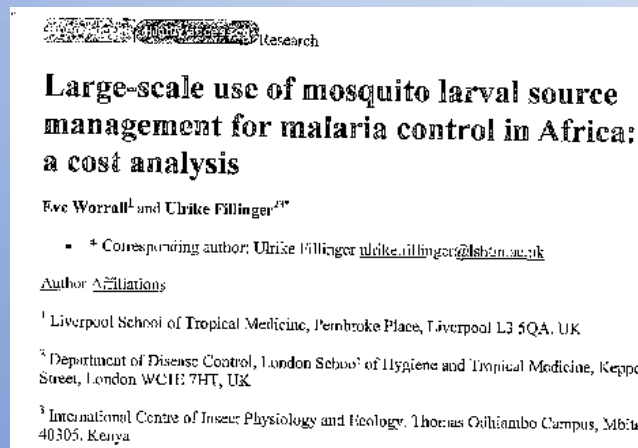


Reduction of the vector population by >70% in the intervention zone.

Cost-analysis studies for LSM with Bti



Germany: 1.50 Euros/person/year



Kenya: 1.11 US\$/person/year



Burkina-Faso: 1 Euros/person/year

Some additional proofs of the efficiency of LSM in the fight of Malaria

Some other successful IVM programs including LSM:

- Khartoun, Sudan: S.M. Elkhalifa, I.O. Mustafan, M. Wais and E.M. Malik, 2008, **Malaria control in an urban area**: a success story from Khartoum, 1995–2004
- Dar es Salaam, Tanzania: Fillinger, U., Kannady, K., William, G. et al. **A toolbox for operational mosquito larval control**: preliminary results and early lessons from the Urban Malaria Control Programme in Dar es Salaam, Tanzania. *Malar J* 7, 20 (2008). <https://doi.org/10.1186/1475-2875-7-20>
- **The Cochran study**: initiated by our WG supported these results and is available: Tusting LS, Thwing J, Sinclair D, Fillinger U, Gimnig J, Bonner KE, Bottomley C, Lindsay SW. Mosquito larval source management for controlling malaria. *Cochrane Database of Systematic Reviews* 2013, Issue 8. Art. No.: CD008923. DOI: 10.1002/14651858.CD008923.pub2. Accessed 26 November 2020.

Conclusion and recommendation

LSM should be considered as the 4th column beside LLINs, IRS and effective diagnosis and medical treatment of malaria cases whenever it is feasible and applicable

RBM programme should provide a certain amount (at least ca. 10 %) of the available money for LSM, our WG should select projects feasible to reach our goals.

THANK YOU
for your
ATTENTION!