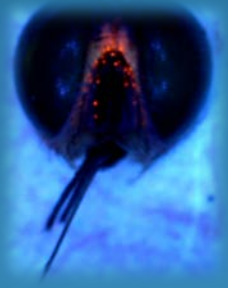
The eradication of the tsetse fly *Glossina palpalis gambiensis* from the Niayes of Senegal using an area-wide integrated pest management approach that includes the release of sterile males


Baba SALL 1, Momar Talla SECK2, Jérémy BOUYER3, Marc J.B. VREYSEN4

1 Direction des Services vétérinares/ Ministère de l'Elevage et des Productions animales
2Laboratoire national de l'Elevage et de Recherches vétérinaires/ Instutut Sénégalais de Recherches Agricoles
3 CIRAD, UMR ASTRE « AnimalS, health, Territories, Risks and Ecosystems »
4Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, International Atomic Energy Agency

MINISTÈRE DE L'ÉLEVAGE

ISRA

FAO FIAT PANIS

IAEA

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

CIRDES

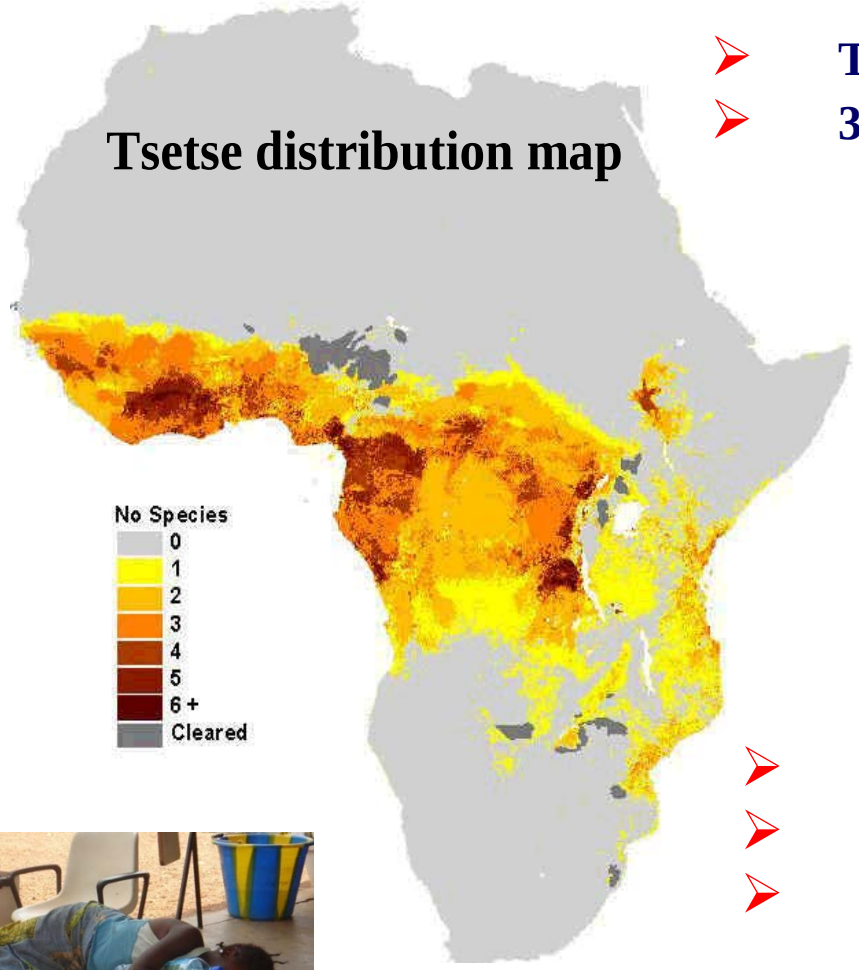
cirad

Overview

- The tsetse and trypanosomosis problem
- Tsetse eradication in the Niayes, Senegal using a Phased conditional approach (PCA)
  - Organisational frame work (Government)
  - Feasibility studies
  - Pre-operational phase
  - Operational phase
- Achievements
- Conclusions

The problem

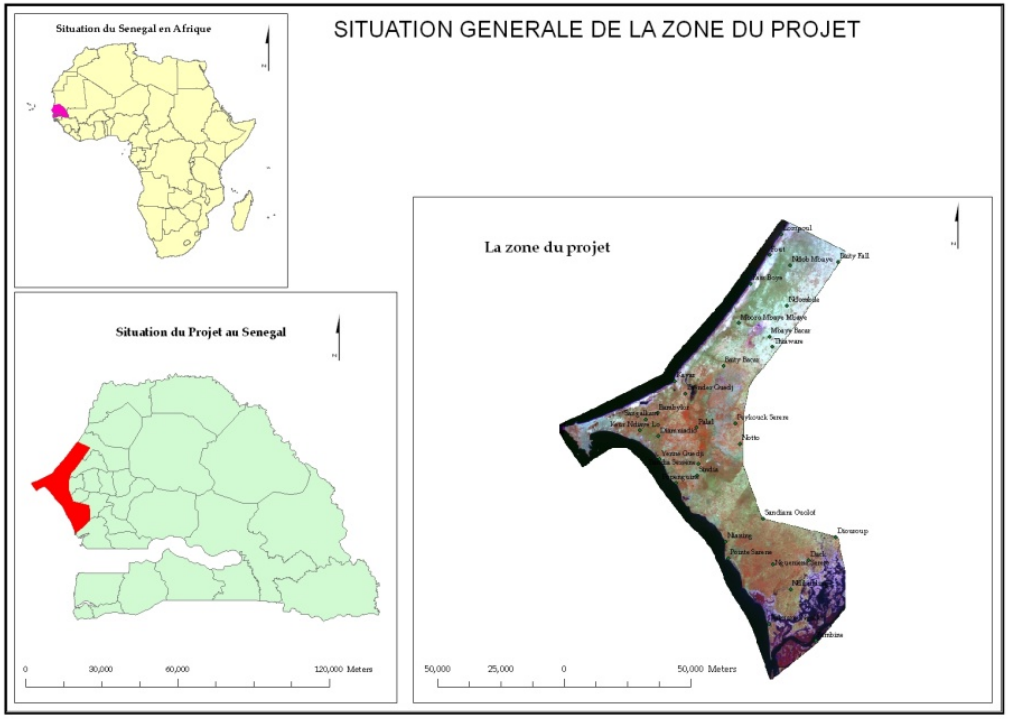
Distribution of *Glossina* spp in Africa



- The Tsetse fly – Africa's Bain
- 36 countries – 10 million km^2
  - 165 million cattle in Africa
  - only 10 million in tsetse infested areas
  - 50 million cattle at risk
  - Direct losses: US$ 0.6 – 1.2 billion EACH YEAR
  - Responsible for separation of crop farming and livestock production
- 60 million people at risk
- 3-4 million people: surveillance
- 300,000 – 5000,000 infected (10%)

The target area in Senegal: Niayes

- Good climatic conditions
- Trypanosomosis = main constraint
- Tsetse eradication = to create a suitable sanitary context for innovation



History of tsetse control in the Niayes of Senegal

- ✓ **1970-1980:** tsetse control in the Niayes (Dr Touré)
  - ✓ Insecticide (spray)
  - ✓ Bush clearing
- ✓ 1980- 1999: No activities
- ✓ **1999-2003:** 2 surveys confirmed presence of tsetse (locale population or reinvasion from other tsetse infested areas? and trypanosomosis

New project with a new approach and new tools

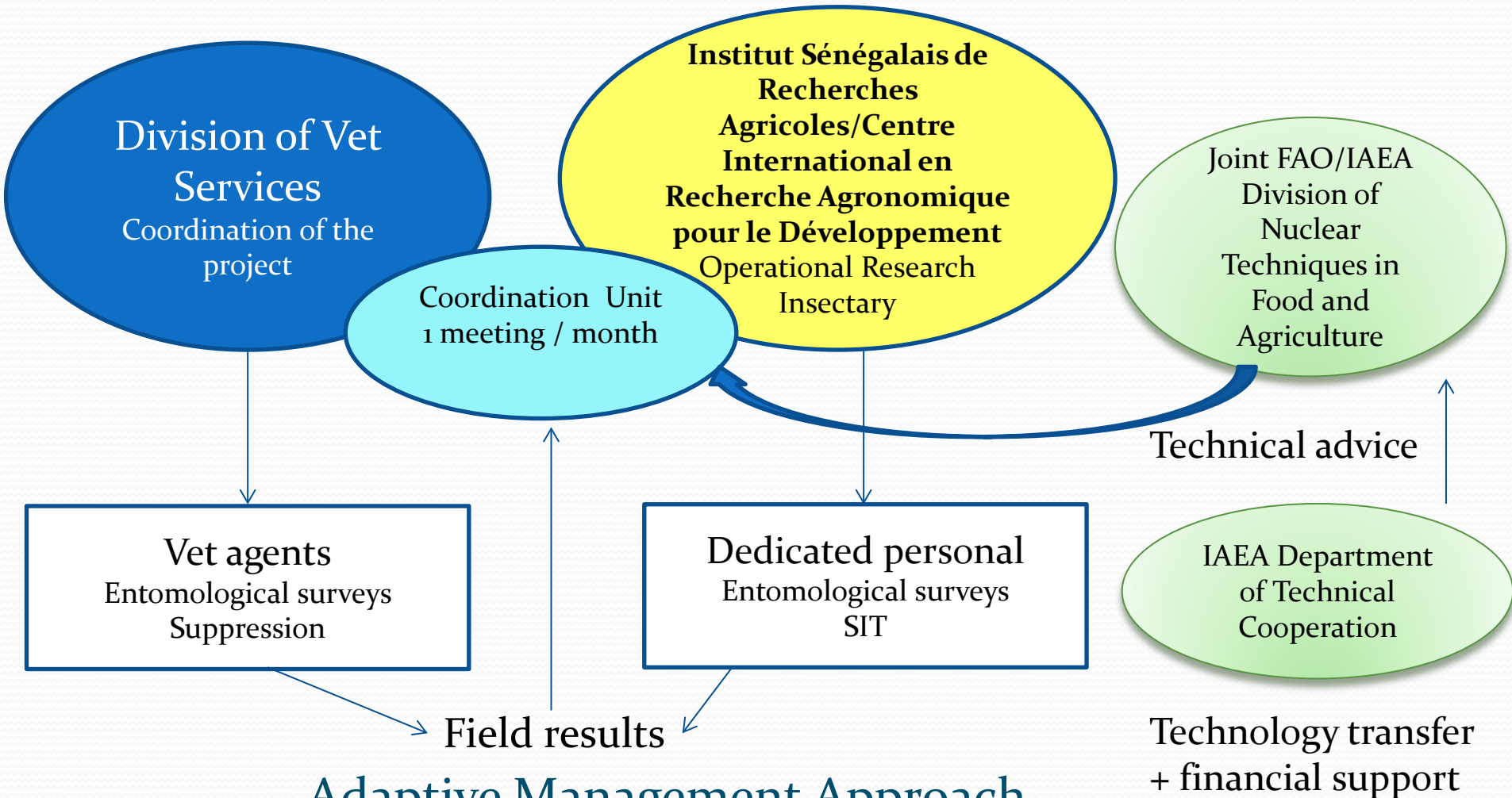
Phased Conditional Approach (PCA)

1. Organisational frame work (Government)
   a. Training of technical field and insectary staff
2. Feasibility studies
   a. Entomological, parasitological and serological base line data collection
   b. Population genetics, socio economics, environmental study
3. Pre-operational phase
   a. Establishment of insectary (dispersal centre in Dakar)
   b. Research at IPCL: transport protocol of male sterile pupae (from Burkina Faso and Slovakia to Senegal)
   c. Pilot release (ground and air) (3 years)
   d. Development of distribution model

External Review

4. Operational phase
   a. Suppression
   b. Release of sterile males
   c. Monitoring of project progress.

PCA1: Organizational frame work

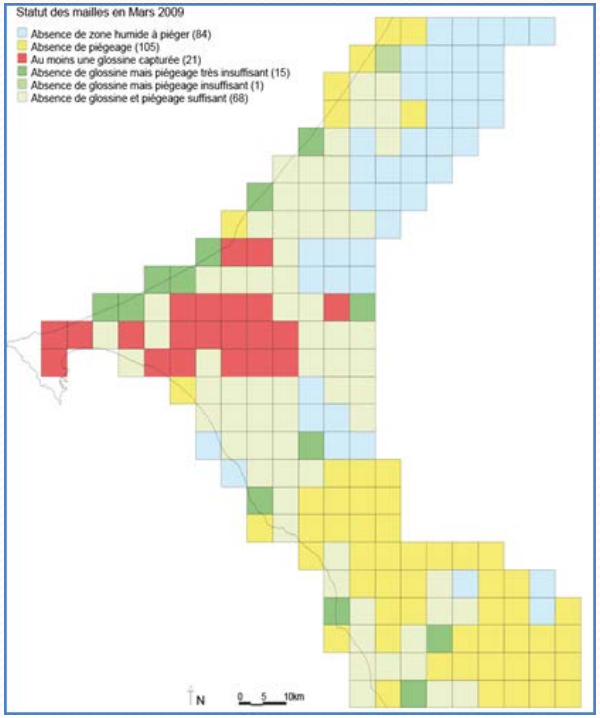


PCA1: Preparation

- 16 field and insectary staff trained
  - CIRDES
  - Tsetse ecology and biology
- Workshop to plan baseline data collection
- Equipment: traps, microscopes, binocular microscopes, sampling material,…

PCA 2: Entomological base line data

- A grid with 5 x 5 km cells to cover the entire target area (total: 294 grids,)
  - Dividing of the area in teams
  - Organisation of the teams
- Development of vegetation maps
- Initial surveys to associate vegetation types with preferred tsetse habitat
- Selection of trapping sites using GIS and RS



PCA 2: Entomological base line data

Gallery forests

Riparian tickets

Swamp forests

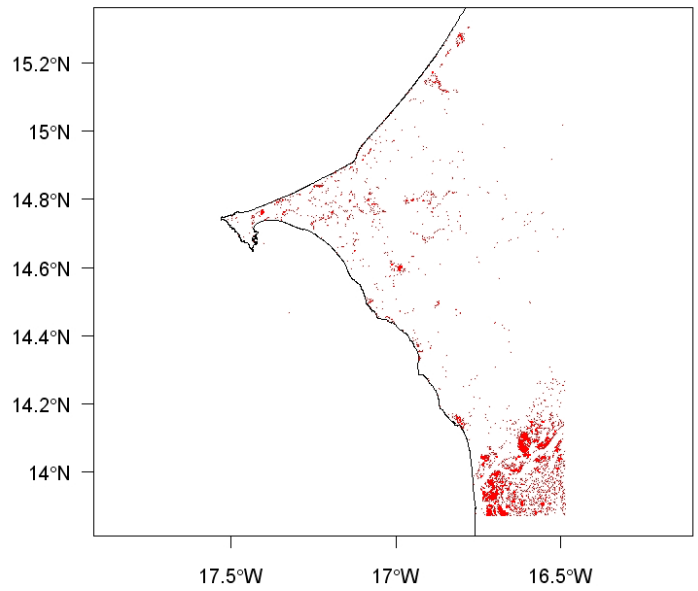
Palm tree plantations

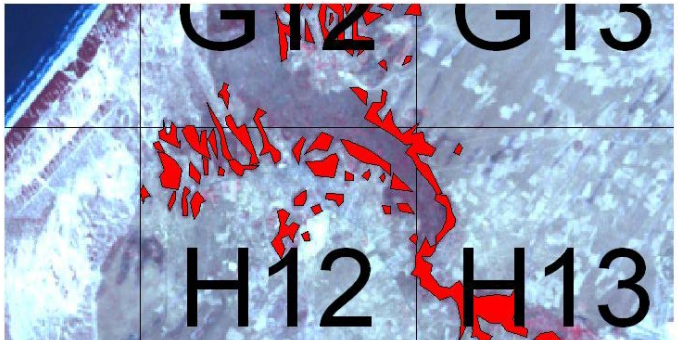
Tree orchards

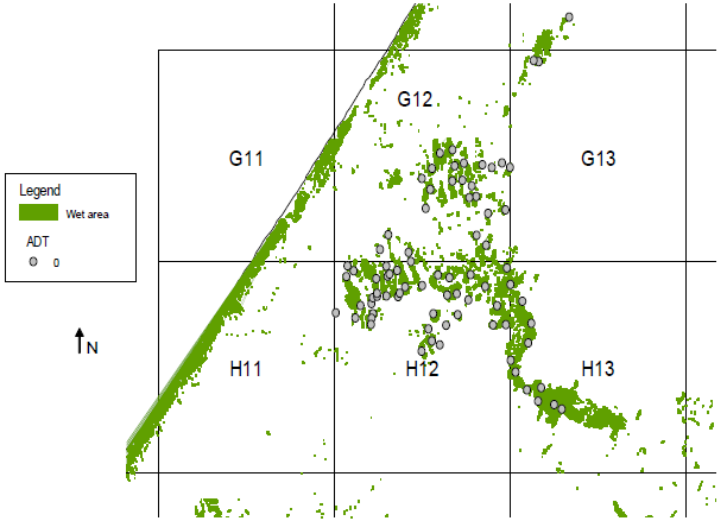
Mangroves

PCA 2: Entomological base line data

Mapping of suitable habitat – selection of trapping sites







GIS – RS: suitable habitat (525 km^2)

> 700 trapping sites

PCA 2: Entomological base line data

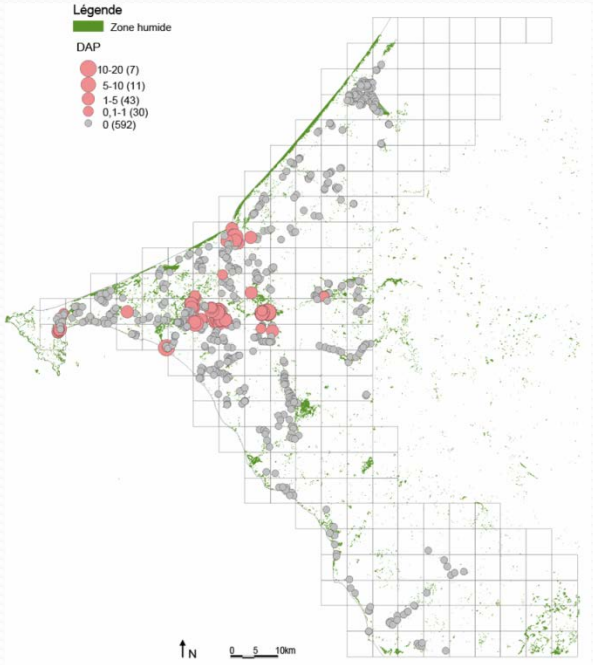


Fig. 5 Localisation des pièges posés et densités apparentes par piège et par jour (DAP)

- 55/294 grids infested (1375 sq. km out of 7350)

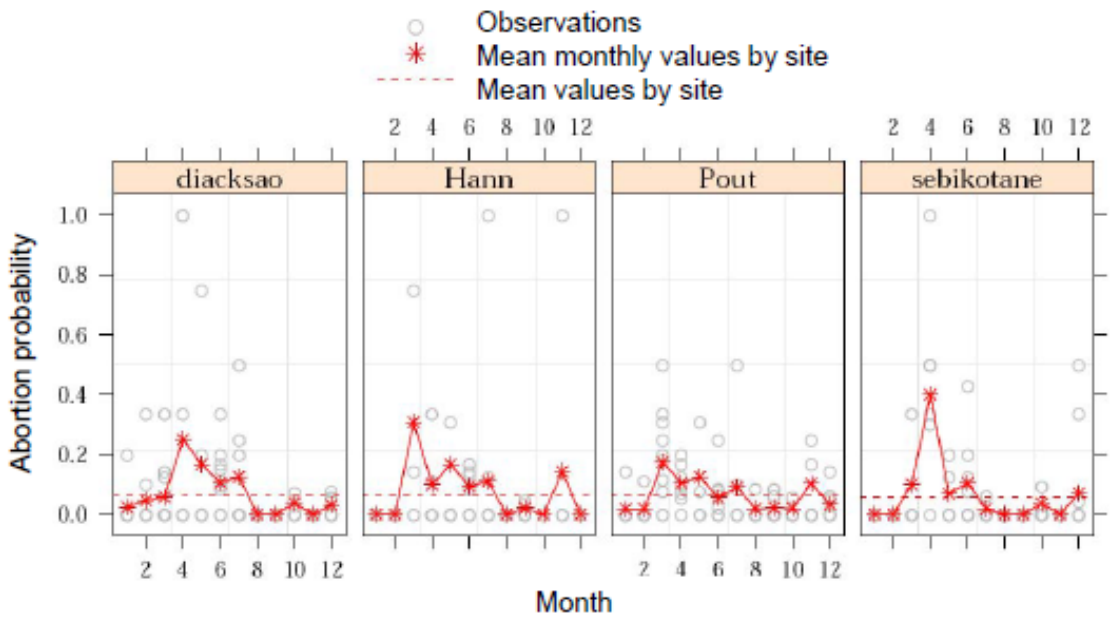
- 1 species: *Glossina palpalis gambiensis*
- 3 populations: Hann, Kayar and Pout
- Densities could be very high locally
- Populations appeared to be isolated

PCA 2: Entomological base line data

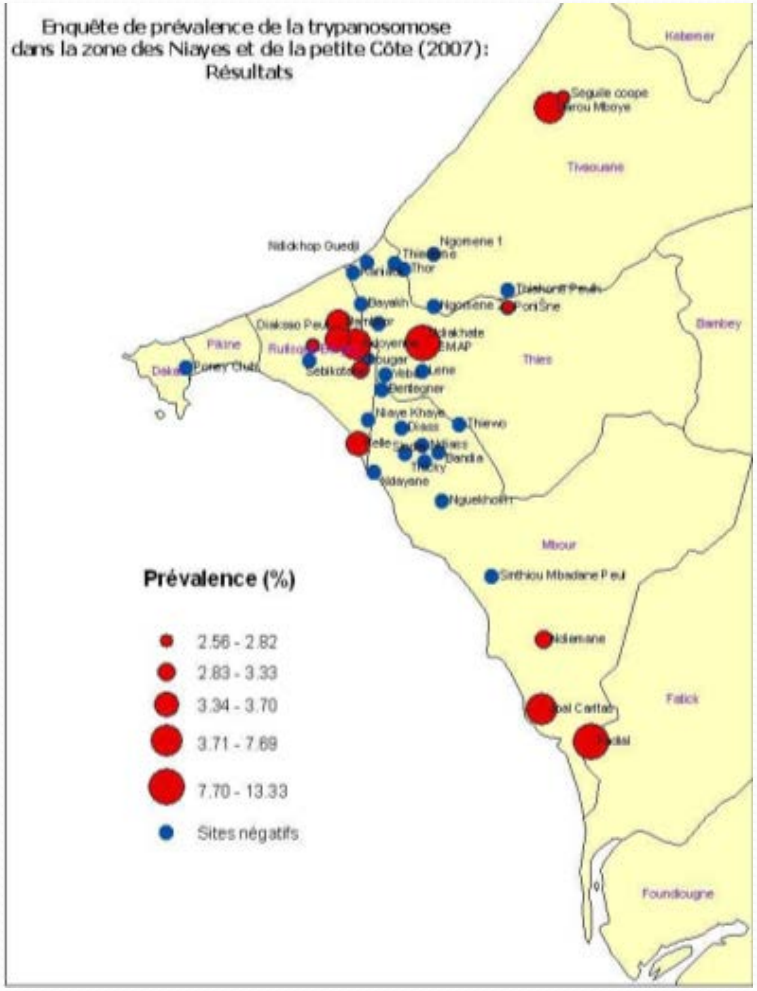
Information about population dynamics

- Apparent densities in different seasons and different ecosystems
- Natural abortion rates

Evolution of the natural abortion rate



PCA 2: Parasitology base line data



Cattle

Mean prevalence

Buffy coat: 2.01%

Serology:

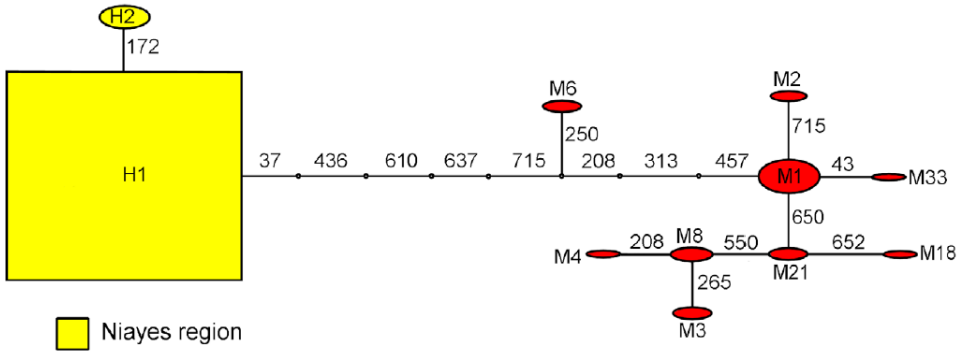
T. vivax 28.68%

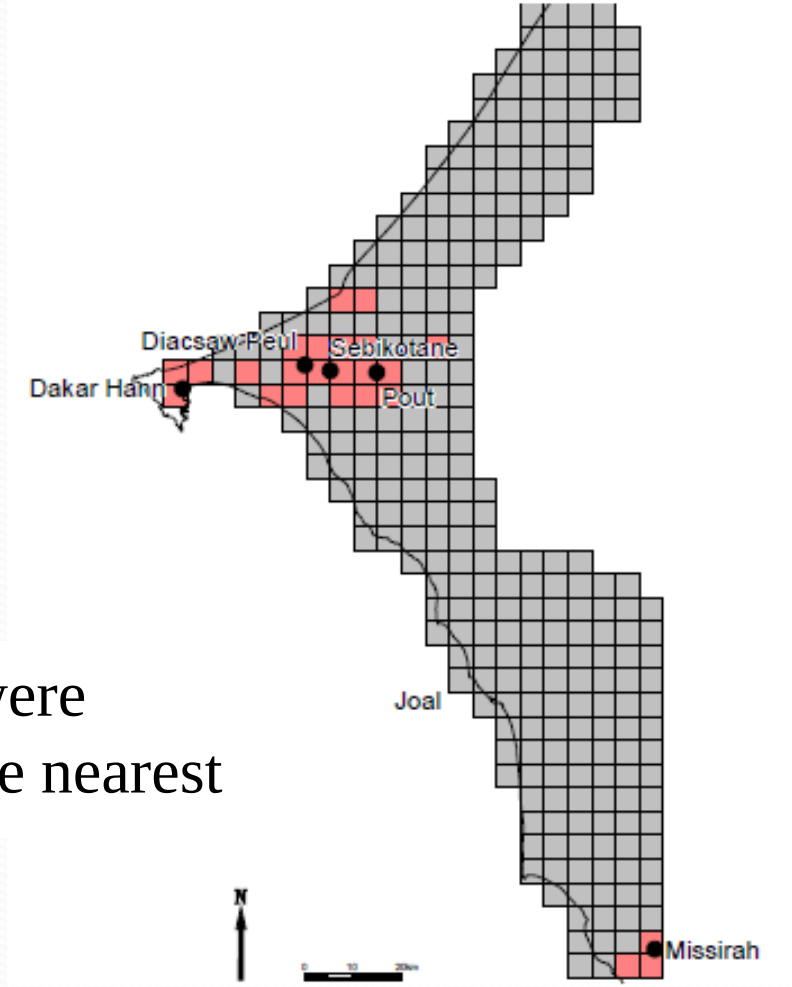
T. congolense 4.36%

T. brucei brucei 0.3%

Strong relationship with tsetse

PCA 2: Population genetics study





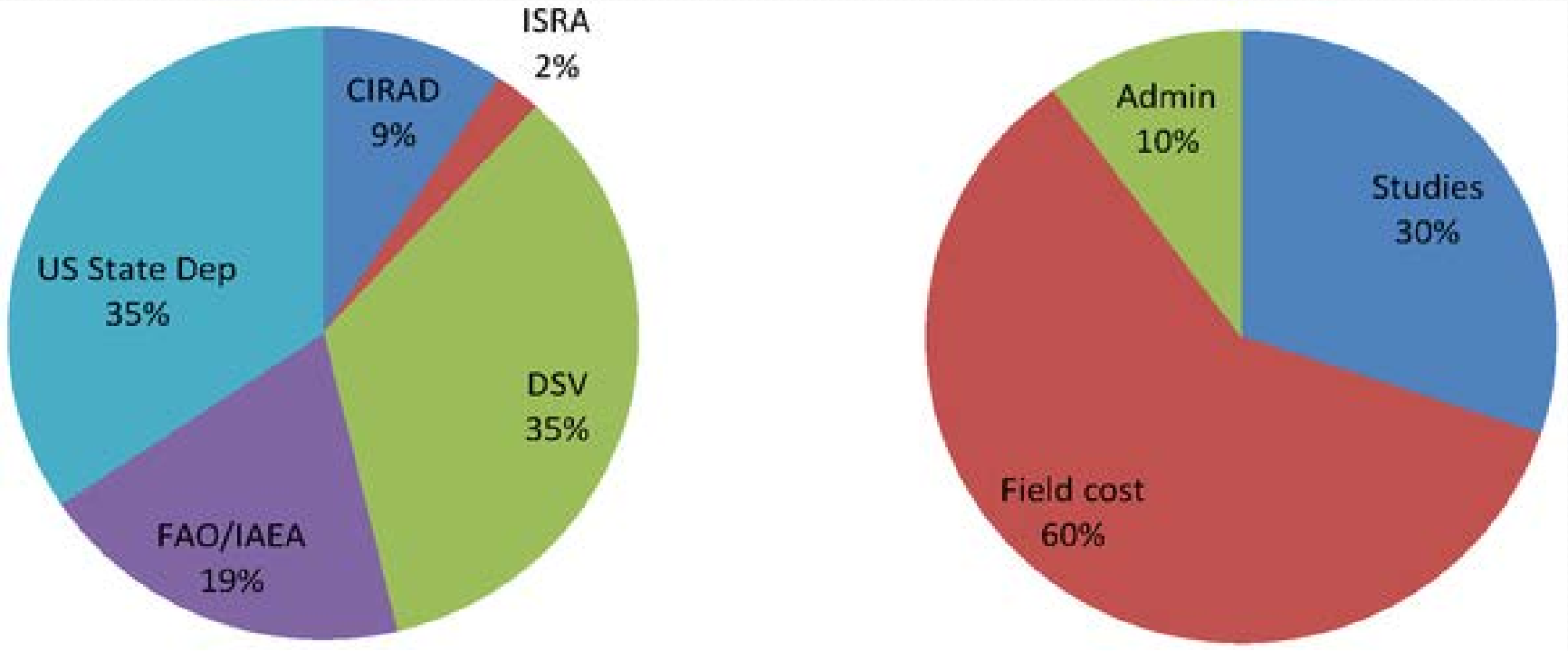
3 markers

- Microsatellites
- Mitochondrial DNA
- Wing morphometrtics

- Niayes tsetse populations were genetically isolated from the nearest population in the South
- No exchange of genes

PCA 2: Socio-economics study

- ~ 6.4 million Euro until 2016 (~€ 6400/km²)

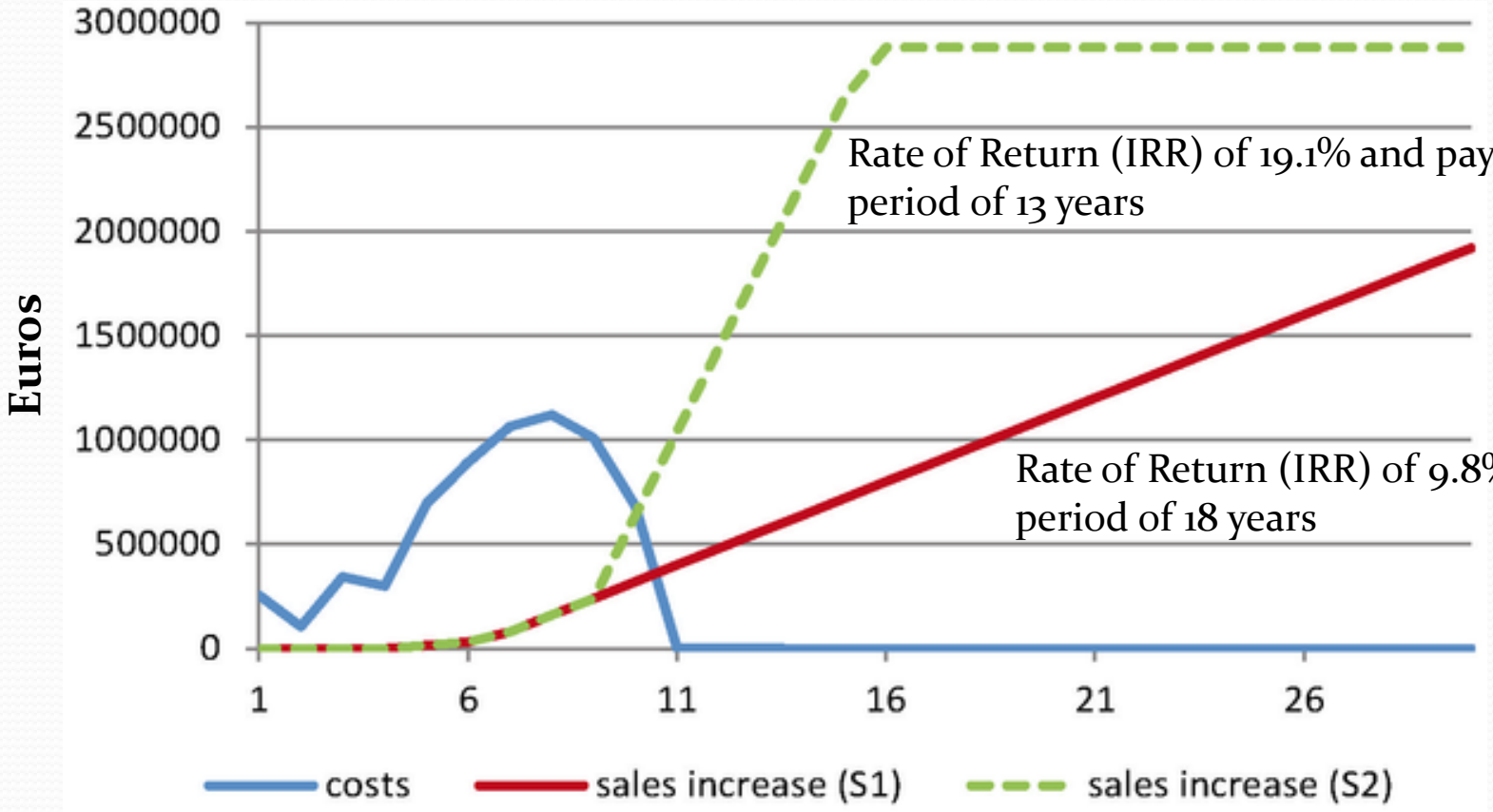


Distribution of the costs by partner (left) and component (right).

PCA 2: Socio-economics study

- One traditional system based on trypanotolerant cattle
  - annual cattle sales €74 (s.d. 38) per head
- Two other livestock keeping systems using more productive breeds (improved meat & improved milk production)
  - annual cattle sales were € 250 (s.d. 513) per head
  - herd size 45% smaller
- Increase of animal sales: **€ 2800 / km^2 /year (total cost € 6400/ km^2)**

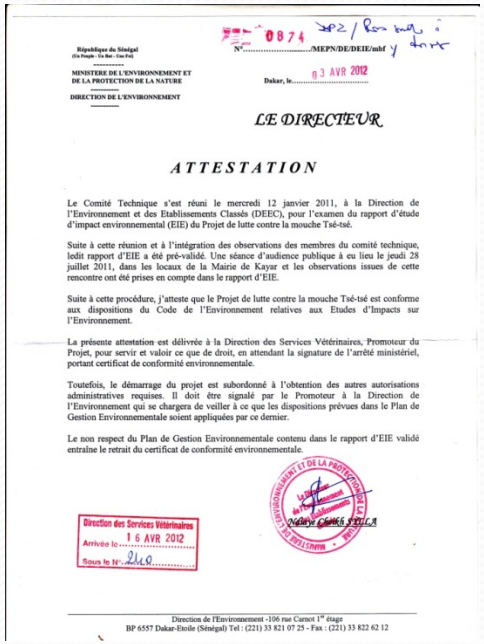
PCA 2: Socio-economics study



PCA 2: Environmental impact study

Permit from the Ministry of environment obtained

Light and transitory impact on non target species



République du Sénégal
(Un Peuple - Un But - Une Foi)

MINISTERE DE L'ENVIRONNEMENT ET DE LA PROTECTION DE LA NATURE

DIRECTION DE L'ENVIRONNEMENT

N°0874 /MEPN/DE/DEIE/mbf

Dakar, le 03 AVR 2012

LE DIRECTEUR

ATTESTATION

Le Comité Technique s'est réuni le mercredi 12 janvier 2011, à la Direction de l'Environnement et des Etablissements Classés (DEEC), pour l'examen du rapport d'étude d'impact environnemental (EIE) du Projet de lutte contre la mouche Tsé-tsé.

Suite à cette réunion et à l'intégration des observations des membres du comité technique, ledit rapport d'EIE a été pré-validé. Une séance d'audience publique à eu lieu le jeudi 28 juillet 2011, dans les locaux de la Mairie de Kayar et les observations issues de cette rencontre ont été prises en compte dans le rapport d'EIE.

Suite à cette procédure, j'atteste que le Projet de lutte contre la mouche Tsé-tsé est conforme aux dispositions du Code de l'Environnement relatives aux Etudes d'Impacts sur l'Environnement.

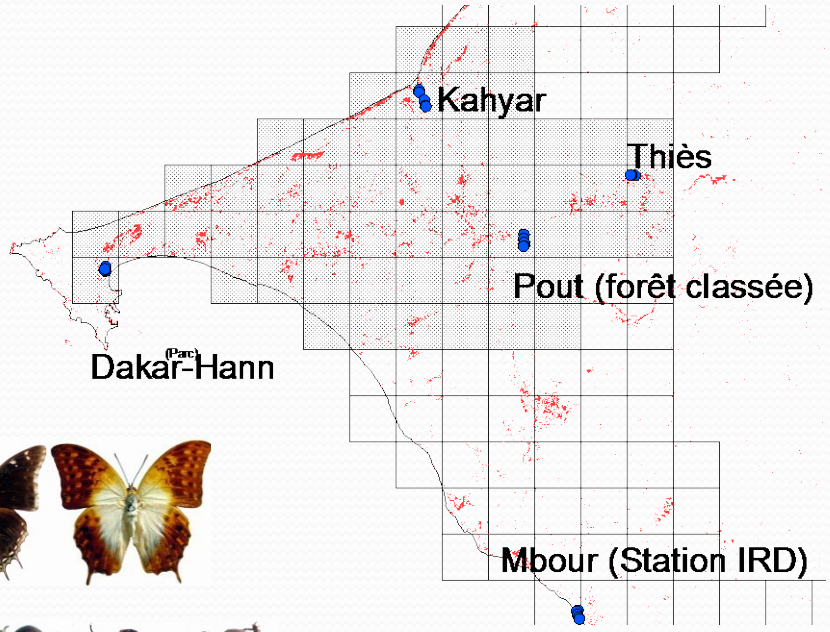
La présente attestation est délivrée à la Direction des Services Vétérinaires, Promoteur du Projet, pour servir et valoir ce que de droit, en attendant la signature de l'arrêté ministériel, portant certificat de conformité environnementale.

Toutefois, le démarrage du projet est subordonné à l'obtention des autres autorisations administratives requises. Il doit être signalé par le Promoteur à la Direction de l'Environnement qui se chargera de veiller à ce que les dispositions prévues dans le Plan de Gestion Environnementale soient appliquées par ce dernier.

Le non respect du Plan de Gestion Environnementale contenu dans le rapport d'EIE validé entraine le retrait du certificat de conformité environnementale.

Direction des Services Vétérinaires
Arrivée le 16 AVR 2012
Sous le N° 2118

Direction de l'Environnement -106 rue Carnot 1er étage
BP 6557 Dakar-Etoile (Sénégal) Tel : (221) 33 821 07 25 - Fax : (221) 33 822 62 12

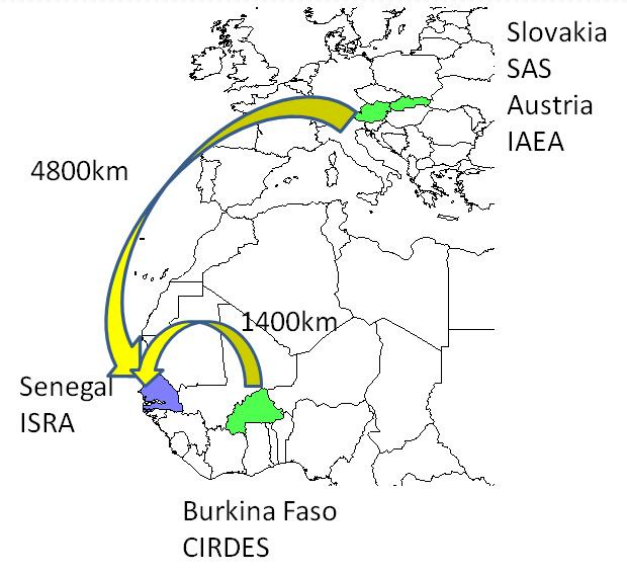


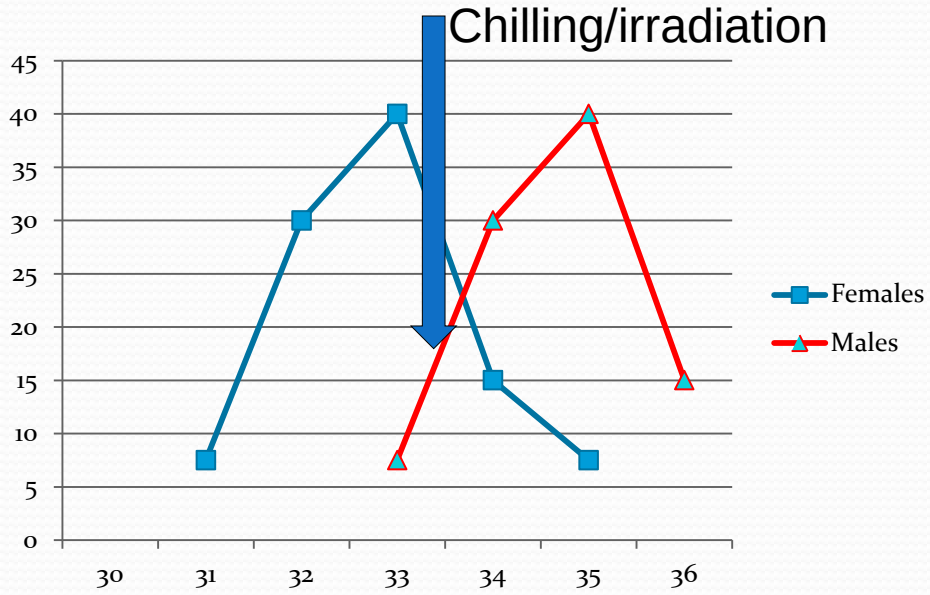
PCA 3: Establishment of a dispersal centre/insectary in Dakar

- Mass-rearing & irradiation in Centre International de Recherche-Développement sur l'Elevage en zone Sub-humide, Burkina-Faso & Slovakia Academy of Sciences, Slovakia / FAO-IAEA Insect Pest Control Laboratory, Austria

PCA 3: Development of a transport protocol

- Transport of pupae, not adults
- Sex sorting to keep females (colony stability)





PCA 3: Development of a transport protocol

- Impact of low temperatures (10, 12.5 and 15 ºC) for various periods of time & irradiation & transport on the quality of sterile males
- Parameters assessed: emergence rate, survival, insemination capacity and field competitiveness
- Development of a quality control test

PCA 3: Development of a transport protocol

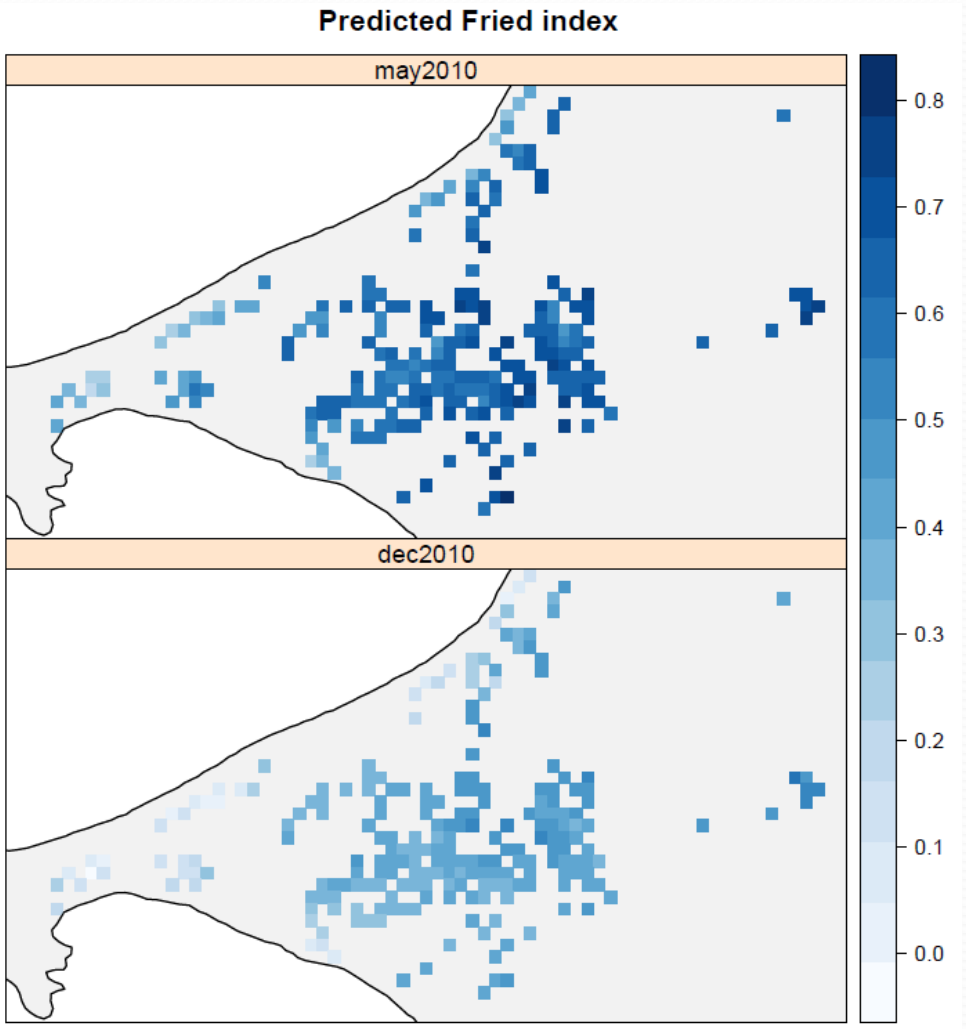
Transport through express mailing services using phase change materials

PCA3: Pilot Release of Sterile Males

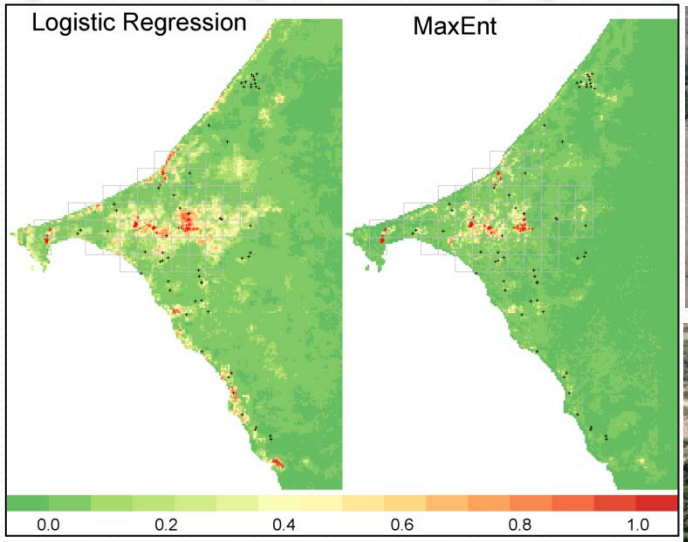
- Trial releases on the ground and with boxed sterile males
- Mortality: releases twice a week
- Dispersal rates: swath widths of 250 m between the flight lines
- Very good competitiveness: ratio 10:1 gives a reduction in fertility > 80%

PCA3: Pilot Release of Sterile Males

Maps of predicted competitiveness



PCA3: Development of distribution models to inform control



PNAS

Using species distribution models to optimize vector control in the framework of the tsetse eradication campaign in Senegal

Ahmadou H. Dicko[a], Renaud Lancelot[b,c], Momar T. Seck[a], Laure Guerrini[d,e], Baba Sall[f], Mbargou Lo[f], Marc J. B. Vreysen[g], Thierry Lefrançois[b,c], William M. Fonta[h], Steven L. Peck[i], and Jérémy Bouyer[a,b,c,1]

[a]Laboratoire National d'Elevage et de Recherches Vétérinaires, Institut Sénégalais de Recherches Agricoles, BP 2057, Hann, Dakar, Sénégal; [b]Unité Mixte de Recherche Contrôle des Maladies Animales Exotiques et Emergentes, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, 34398 Montpellier, France; [c]Unité Mixte de Recherche 1309 Contrôle des Maladies Animales Exotiques et Emergentes, Institut National de la Recherche Agronomique, 34398 Montpellier, France; [d]Unité de Recherche Animal et Gestion Intégrée des Risques, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, 34398 Montpellier, France; [e]Department Environment and Societies, University of Zimbabwe, Harare, Zimbabwe; [f]Direction des Services Vétérinaires, BP 45 677, Dakar, Sénégal; [g]Insect Pest Control Laboratory, Joint Food and Agriculture Organization of the United Nations/International Atomic Energy Agency Programme of Nuclear Techniques in Food and Agriculture, A-1400 Vienna, Austria; [h]West African Science Center for Climate Change and Adapted Land Use, BP 13621, Ouagadougou, Burkina Faso; and [i]Biology Department, Brigham Young University, Provo, UT 84602

PCA4: Sequential eradication

Strategy developed using data from the feasibility study :

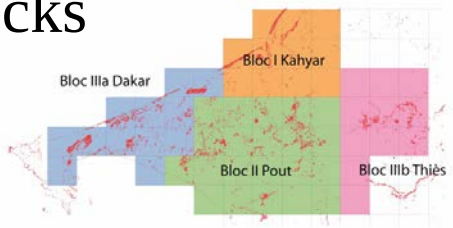
Isolated population – opted for Eradication

High fly densities – need for suppression (insecticide impregnated traps, pour ons)

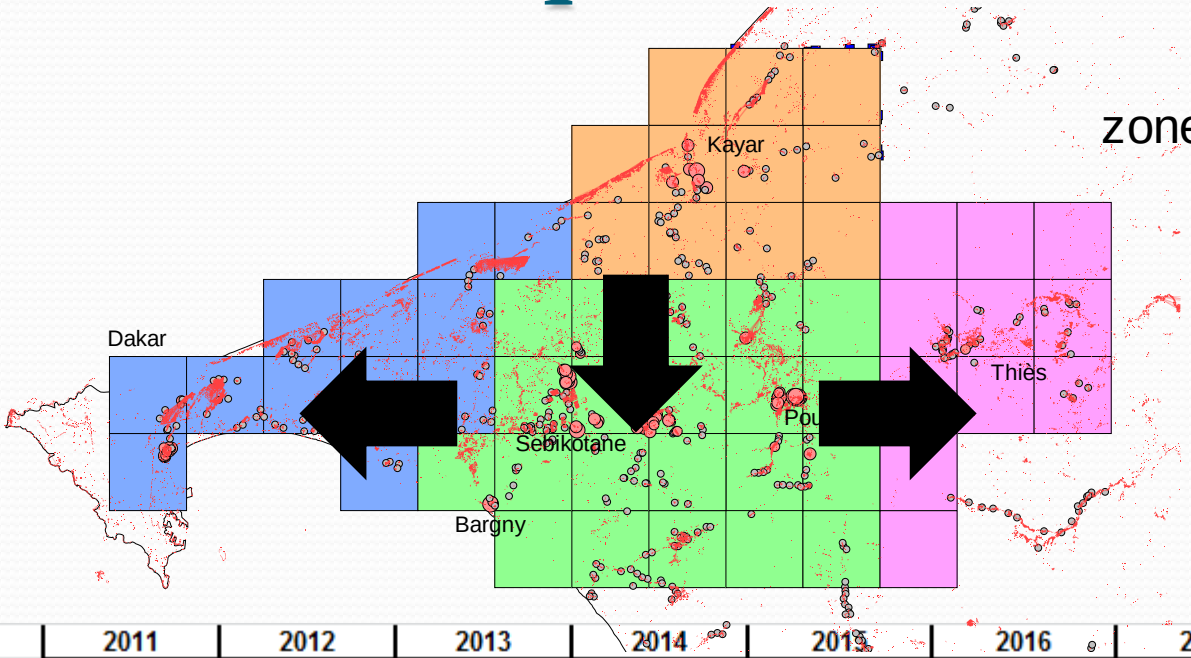
Fragmented nature of the habitat – required the sterile insect technique

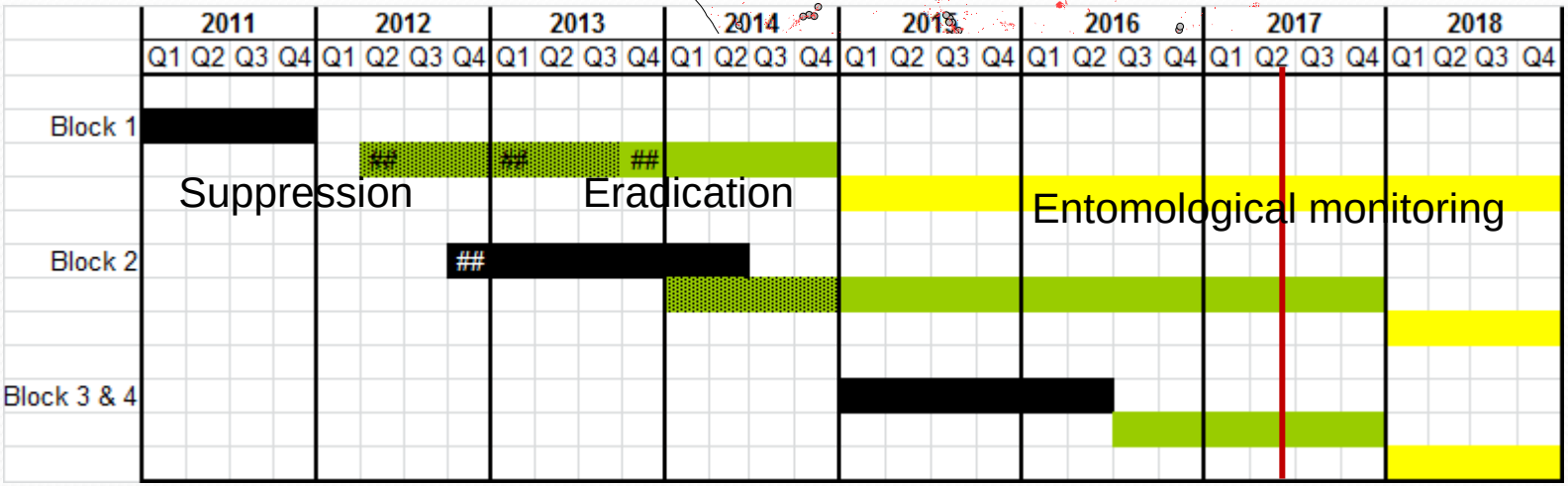
Preoperational phase: tools tested (transport, release system,...)

Phased approach – 3 blocks



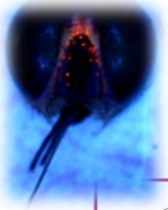
PCA4: Sequential eradication





PCA4: Sequential eradication

Optimization of control based on distribution models: targeting suitable habitats



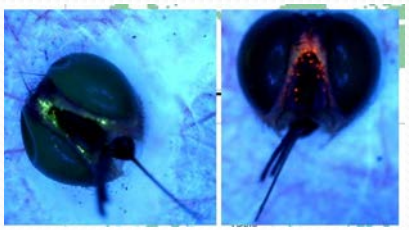
PNAS Celebrating 100 Years 1915-2015

Dicko, A.H., *et al.* (2014) Using species distribution models to optimize vector control: the tsetse eradication campaign in Senegal. *PNAS*.

PCA4: Sequential eradication

Aerial and ground release of sterile males

PCA4: Sequential eradication

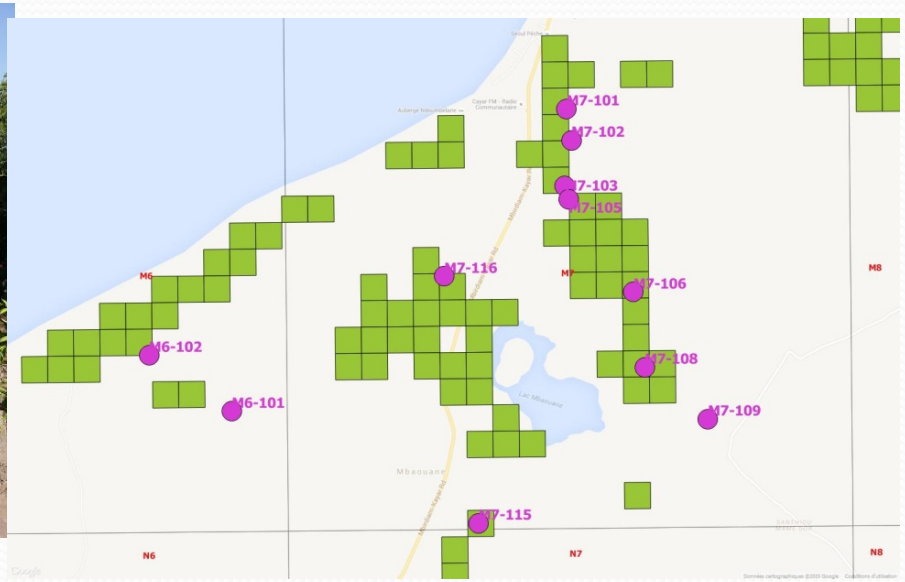


Monitoring system

Block 1: 24 monitoring traps (once a month)

Block 2: 72 monitoring traps (twice a month)

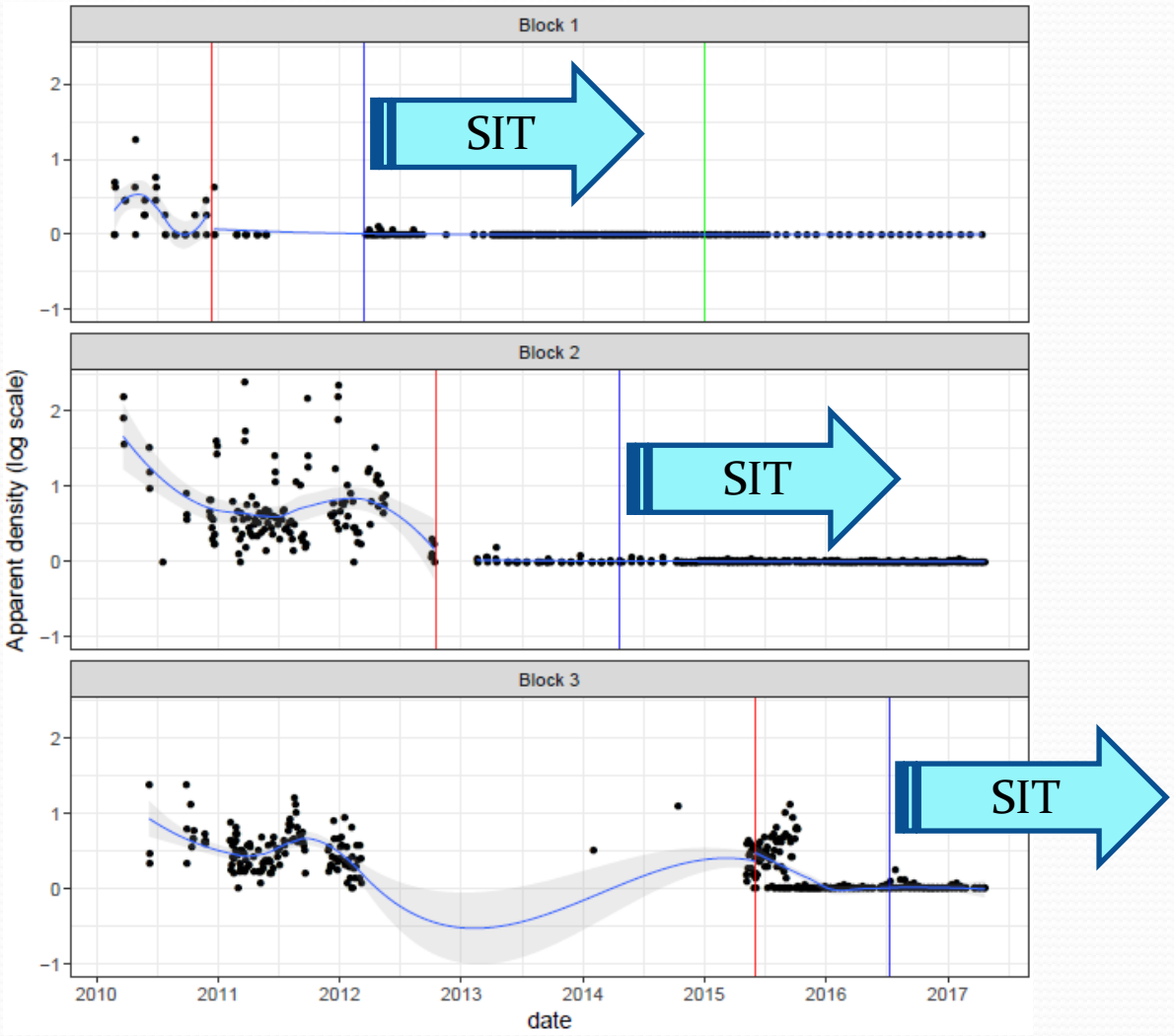
Block 3: 45 monitoring traps (twice a month)



PCA4: Sequential eradication

Achievements

Impact on tsetse populations



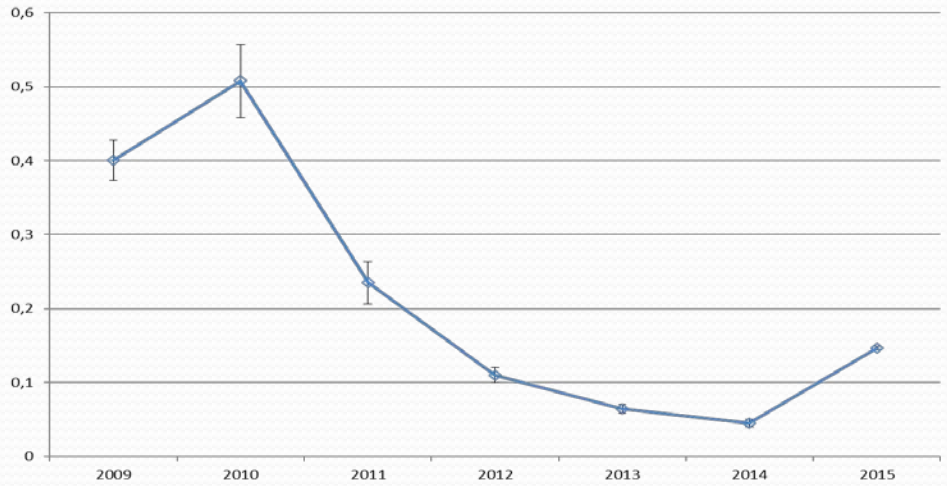
1-3.4 insecticide impregnated targets/km^2

+

10 and 100 sterile males/km^2

unsuitable vs suitable habitat respectively

Impact on disease prevalence in sentinel herds



Progressive replacement of trypanotolerant breeds by improved breeds

Djakoré cross-bred with

ontbéliard

Environmental impact

- ✓ 2 out of 10 non target species (Cetoniina species) slightly affected by the suppression methods: *Pachnoda interrupta in Kayar (block1) and P. marginata in Pout (block 2)*
- ✓ *Both species reached the reference situation (2009) after 2 years*

Weaknesses and strengths

Weaknesses

- Human ressources: Only few staff members are fully dedicated to the project
- Financial challenges
- Lack of sterile flies: project extended over expected deadline

Strengths

- Strong support from FAO/IAEA, CIRAD, USDA
- Strong team management
- Strong involvement of the staff (field and insectary)
- Very good working environment

Conclusions

- Benefits of the campaign already huge
- Change in sanitary context already perceived -> strong innovation anticipated
- **The change of socio-technical regime accelerated** after the eradication process
- Reduction of cattle size and integration between agriculture and cattle breeding promoted

Thanks!