LDAS-Morocco project
Locust invasion monitoring and risk evaluation

Mohammed Faouzi SMIEJ
smiej@crts.gov.ma
CRTS

Meeting CRTS-NASA teams
Washington 1-5th december 2013

OUTLINE

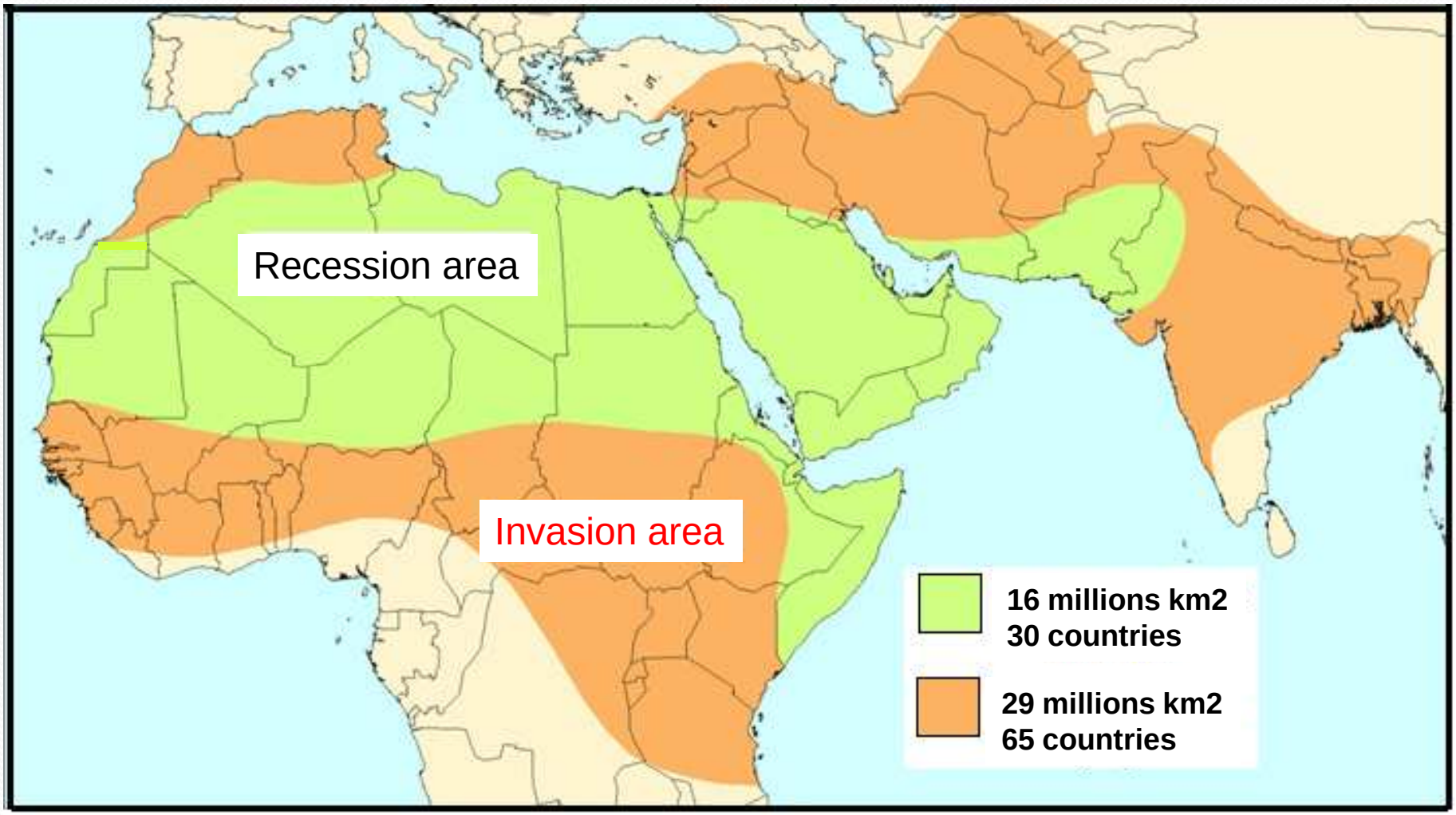
- **Introduction : locust invasion and its socio economic impacts**
- International, regional and national locust fight
- Locust component in the LDAS project
  - Activities description progress and results
  - Planning

Introduction : locust invasion and its socio economic impacts

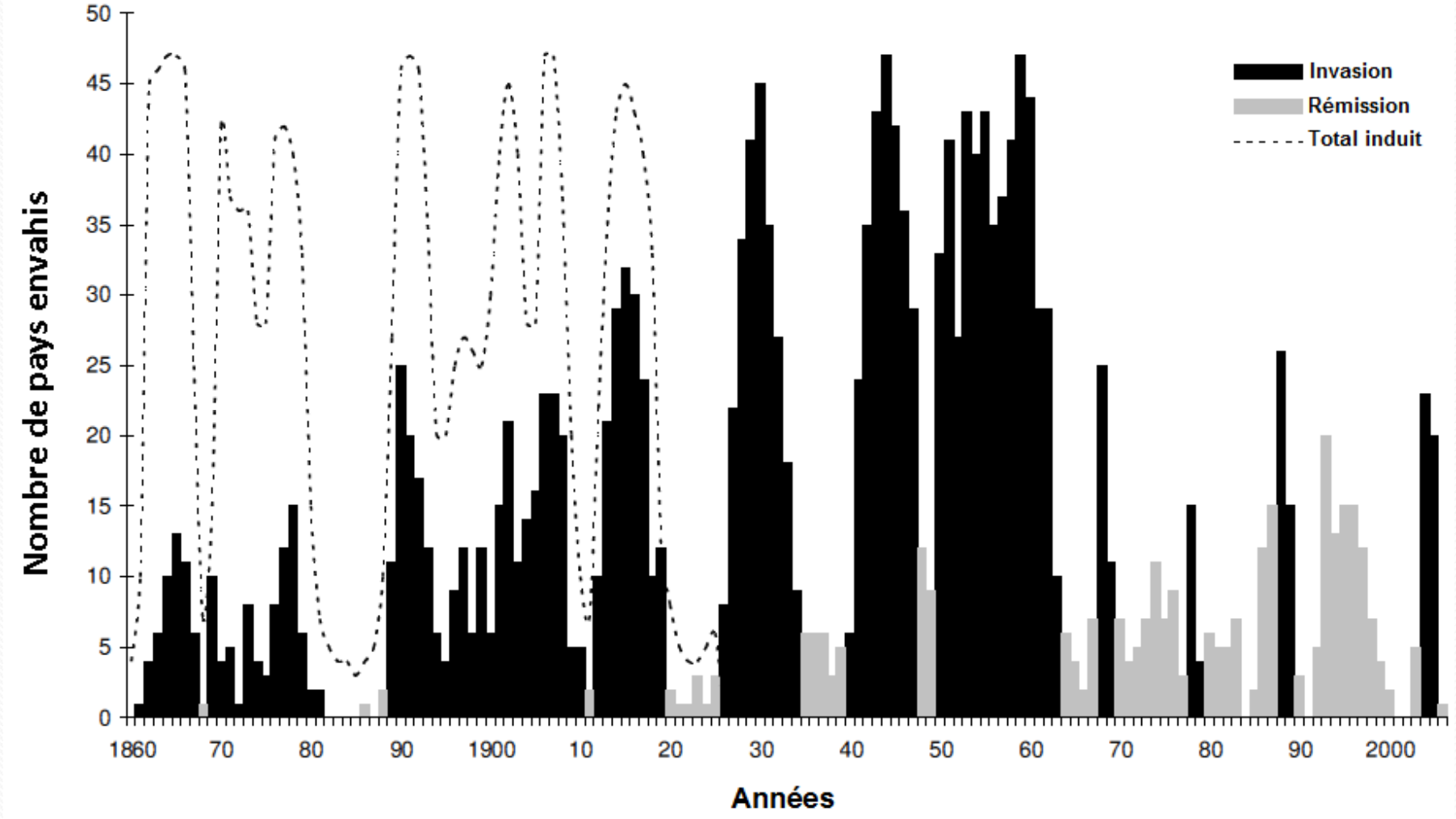
- locust invasion is one of the major humanity scourges for a long time
- it may have a huge devastating socio-economical impacts

- may affects an area of 29,000,000 km ² (20% of land area),
- About 65 countries in Africa and Asia from African Atlantic coasts to the Indo-Pakistan border
- a population of about 1.3 billion people and extending the African Atlantic coasts of the northern hemisphere the Indo-Pakistan border, across 65 countries in Africa and Asia

Introduction : locust invasion and its socio economic impacts



Introduction : locust invasion and its socio economic impacts



Number of Countries affected by locusts swarms between 1860 and 2006 (Walloff 1966, 1976 update by Magor, JI et al, 2007)

Introduction : locust invasion and its socio economic impacts

Years	Country	Value of destroyed crops (in £)	Value en 1986 (in £)
1926 to 1934	India	400 000 per year	6 millions
1928 and 1929	Kenya	300 000 per year	4,5 millions
1953	Somalia	600 000	
1954 et 1955	Morroco	4 500 000 (one season)	40 millions
1949 à 1957	12/40 concerned countries (FAO)	1 500 000 per year ; plus 5 000 000 en 1955	45 millions

Evaluation of Locust Damage examples (Steedman, 1988)

Introduction : locust invasion and its socio economic impacts

	Burkina Faso	Mali	Mauritania
Production loss			
▪ Céréales	80%	90%	90% à 100%
▪ legumes	80% à 90%	80% à 90%	80% à 90%
▪ pasture	30%	30%	85%
▪ forage and fruit trees	50%	50%	80%

Damage observed during 2003-2005 Locust invasion (Brader et al, 2006)

Introduction : locust invasion and its socio economic impacts

Country	Affected population number
Burkina Faso	500 000
Mali	1 000 000
Mauritanie	1 300 000
Niger	3 000 000
Sénégal	1 580 000
Tchad	1 000 000
Total	**8 380 000**

Affected human population by the 2004 locust invasion (Brader et al., 2006).

Introduction : locust invasion and its socio economic impacts

Moroccan case

- In case of generalised invasion, the whole vegetation may be seriousely affected :

- agriculture represents **15** to **20%** of GDP
  * **5.4 million hectares of cereals** (67 %)
  * **760.000 hectares** fruits (9%)

-It employs 42% of the workforce and 80% of the rural labor force.

Introduction : locust invasion and its socio economic impacts

EXAMPLE OF THE ECONOMIC IMPORTANCE OF EXPOSED AGRICULTURAL ZONE Souss-Massa Case (AGADIR MOROCCO)

CROPS	AREA (Ha)	Production Value (millions DH)	Emploiment (Millions WD)
Citrus	**30.107**	**1319**	**6,18**
MARAICHAGES	**13.200**	**2.123**	**9,24**
BANANA	**3.600**	**442**	**1,49**
CEREAL	**106.560**	**232**	**1,25**
OLIVE	**19.615**	**25**	**0,60**
ALMOND	**7.372**	**14**	**0,11**
FEED	**11.425**	**801**	**0,20**
TOTAL	**191.879**	**4.956**	**19, 06**

During the 2004 locust invasion, the effectiveness of post treatment has limited the extend of damage :
The volume of the agricultural production was not a lot affected by this invasion.
Need to focus more effort to further ressource conservation

Introduction : locust invasion and its socio economic impacts

Locust damage on millet in Louga in Senegal in 2004

Introduction : locust invasion and its socio economic impacts

The extent and frequency of damage by locust invasions has led the international community to work closely together to deal with this plague

OUTLINE

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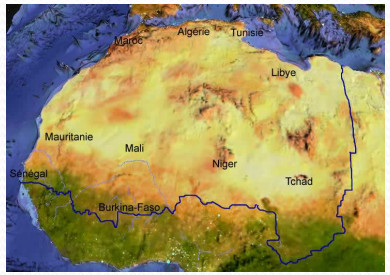
International system of locust control



Desert Locust Control Comitee (FAO)

Global

Regional

CLCPRO Commission de lutte contre le criquet pélerin dans la région occidentale

Centre National Lutte Anti ACRIDIENNE 'CNCLAA (Morroco)

National Center Mauritania

Desert Locust Control Organization for Eastern-Africa (DLCO-EA)

National Centers

Near East comitee

National Centers

National Centers

National

International system of locust control

Global Coordination : Desert Locust Control Comitee (DLCC, FAO)

- Represented of 60 affected countries and donors.
- Responsible of international coordination activities related to locusts :
  - defines the strategy of locust fight activities,
  - mobilizes resources for control operations,
  - encourages the coordination during the campaigns,
  - strengthen international cooperation.

Return

International system of locust control

Regional Coordination

- The DLCC is relayed by 3 regional Commissions created under the auspices of FAO :
  - The Middle East and Southeast Asia
  - The CLCPRO for the Western Region
  - The Desert Locust Control Organization for Eastern-Africa
- Role of commissions : promoting, at national regional and international scales, actions, research and training to achieve preventive control and facing locust invasions

Return

National locust control organisation : case of Morocco

REMISSION PERIOD

CRISIS PERIOD

Centre National de Lutte Antiacridienne (CNLAA)

Central Coordination Poste (PCC)

Agriculture, Interior Defense , Health, Finance, Meteorologie Departments

National

Regional

Regional Coordination Postes (PCR) : 13

7 at south and south east border : 1st defense line
3 belong the Atlas mountain chain : 2d defense line
3 insid the country: 3d defense line

Local

Sub regional coordination postes (SPC) : 40
---
3 to 5 SPC for each PCR

At field

Mobile operational units

Moroccan locust control general strategy

The control strategy is based on a plot of three lines of defense:

- the first front closed to the nearest border;
- A second line in front of the growing areas (near Atlas mountain;
- A third line close to growing areas.

OUTLINES

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- International, regional and national locust fight
- **LDAS project : Locust Component**
  - Activities progress and results
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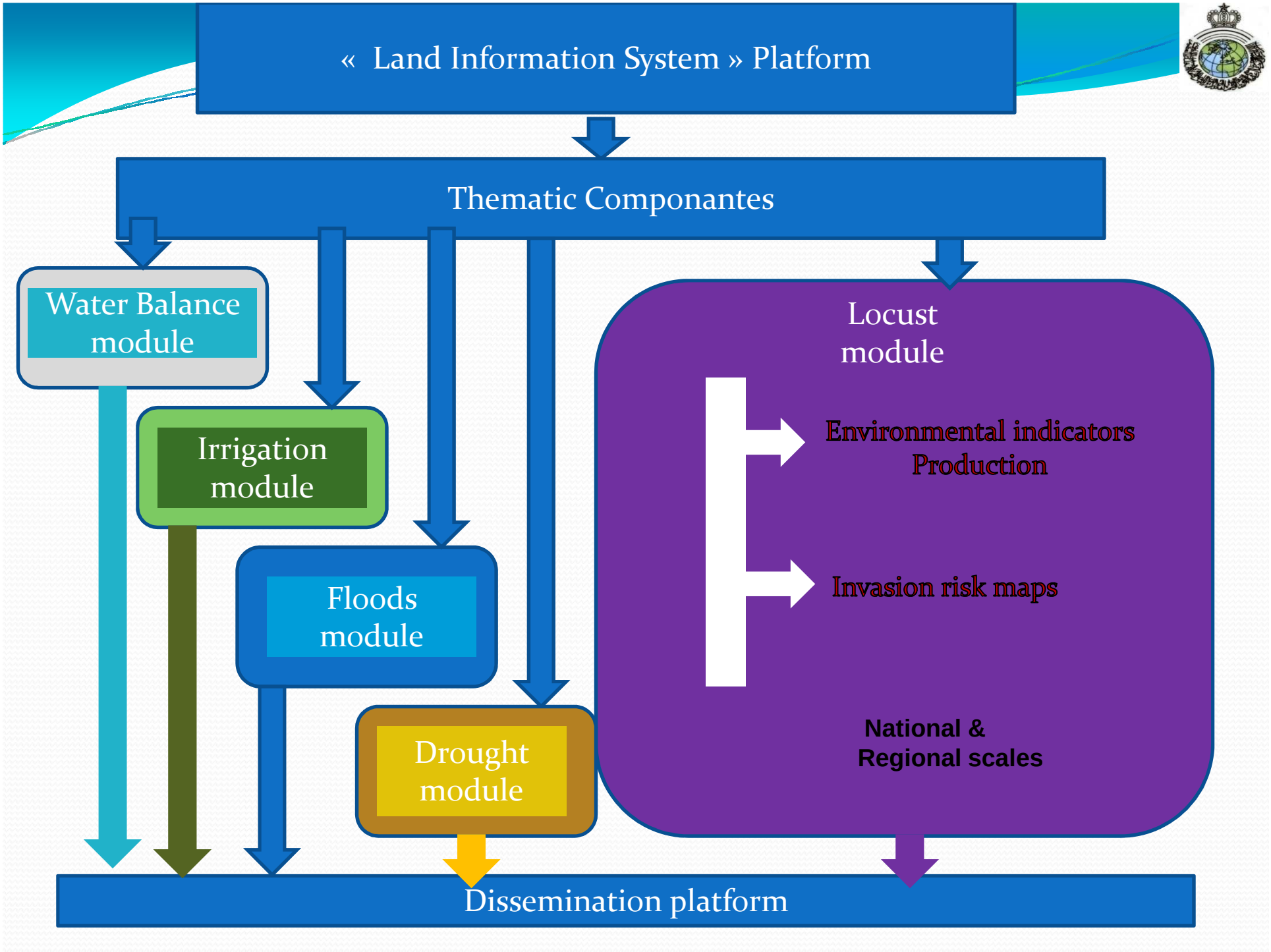

« Land Information System » Platform
Thematic Componantes
Water Balance module
Irrigation module
Floods module
Drought module
Locust module
Environmental indicators Production
Invasion risk maps
National & Regional scales
Dissemination platform

Module description

Main Goal : improving prevention, monitoring and risk control process of the locust invasion in Morocco using environmental parameters provided by LDAS platform

Specific goals :

- Use LDAS platform to generate additional environmental products related to the locust development and migration
- Establish a methodology to produce locust invasion risk maps which help exploration operations at the local and regional levels (reducing costs and improving efficiency)

LDAS PROJECT AND LOCUST FIGHT PROCESS

Beneficary

- The « Poste de Coordination Central de la Lutte AntiAcridienne » (**PCCLAA**) : decisional organ and coordinator at national level.
- **Partners**
  - Main Partner : « Centre National de Lutte AntiAcridienne » (**CNLAA**) in charge of:
    - Conducting and piloting locust control
    - Physiological studies on desert locust,
    - research activities about means and methods of control and impacts of used pestecides on human and animal health.
    - Centralising information and expertise on the different national locust control campaigns.
  - International partners : NASA, FAO(Rome), VITO (Belgique), H-SAF EUMETSAT, CIRAD
  - Institut Agronomique et Vétérinaire Hassan II (IAV)

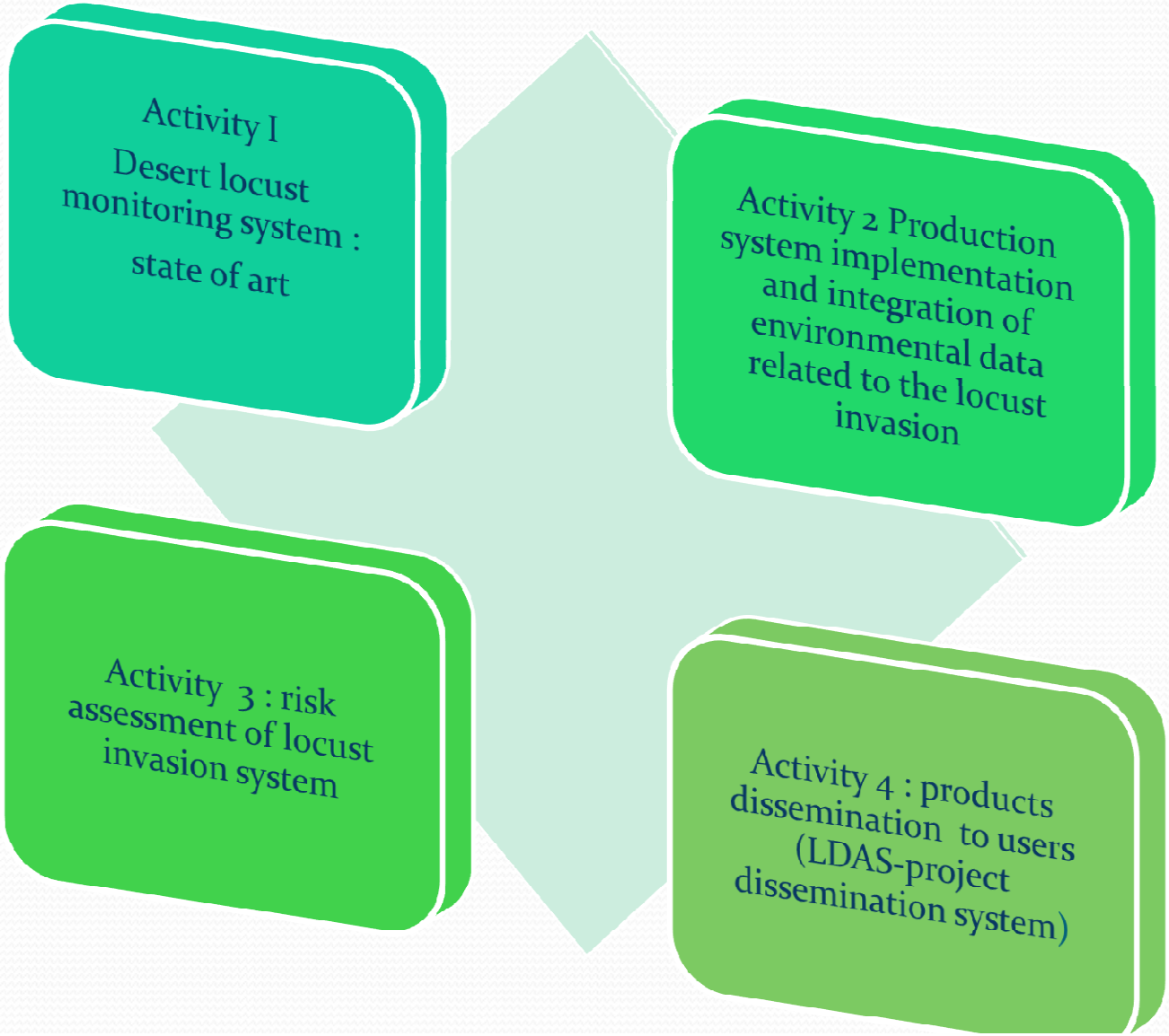
Human ressources

- Leader of the activity (CRTS)
- National experts from CNCLAA, IAV, ….
- International experts
- 1 PHD

Capacity building enhancing

- International experience on locust monitoring
- Soil humidity estimation from RS data
- Risk Maps Modelling process
- Meetings and international seminaries

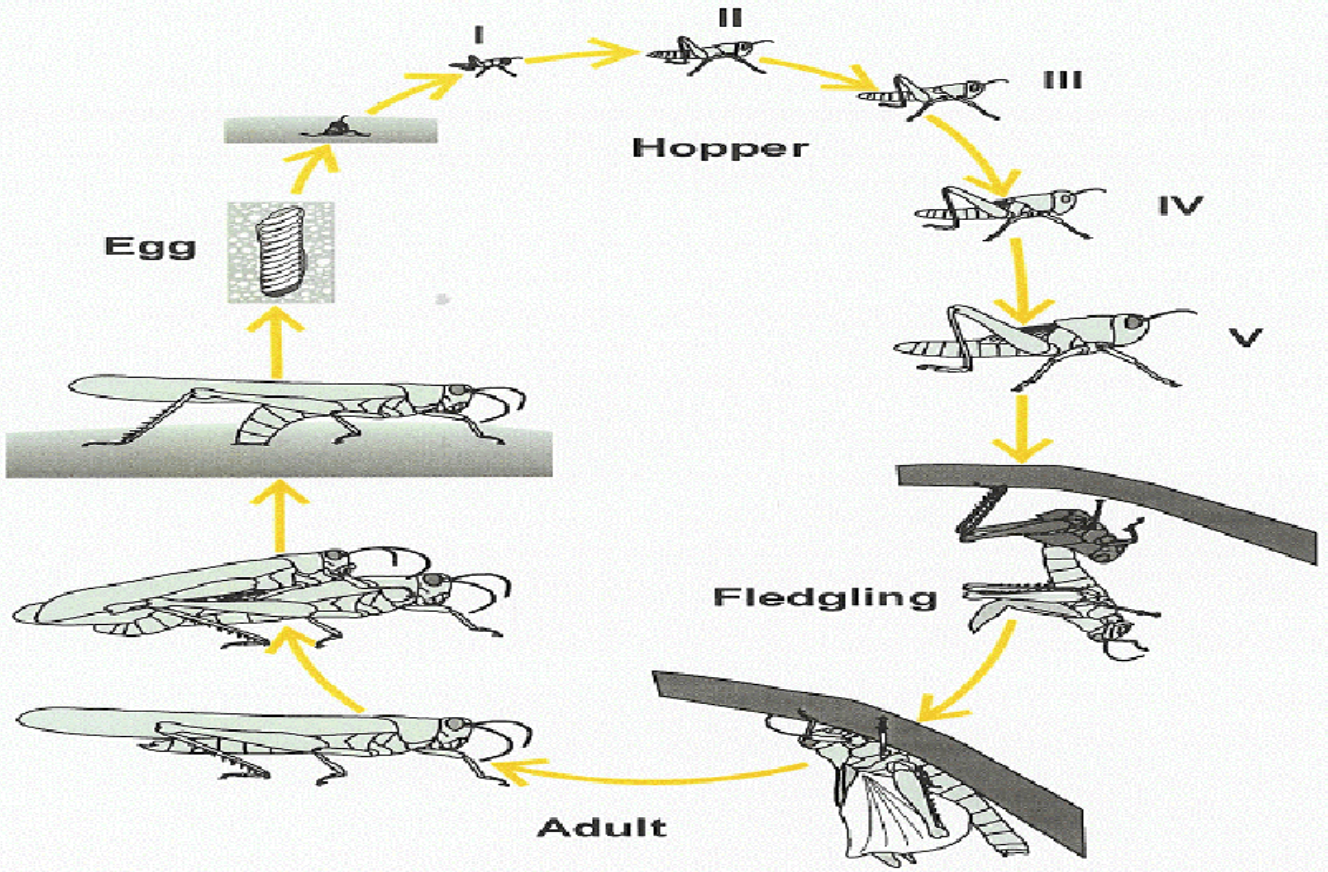
LDAS PROJECT : LOCUST COMPONENT
Activities



LDAS PROJECT : LOCUST COMPONENT
Activity I state of art

- Recruitment of local expert for two tasks :
- Task 1 :assess environmental conditions for locust evolution. To have good knowledege on :
  - evolution cycle of locust in the West Africa region;
  - favorable environmental conditions for different stages of locust development
  - Spatio temporal caracterisation of recrudescence and migrationn
  - List and description of international databases related to locust control
- Task 2 : assist the risk map modeling team

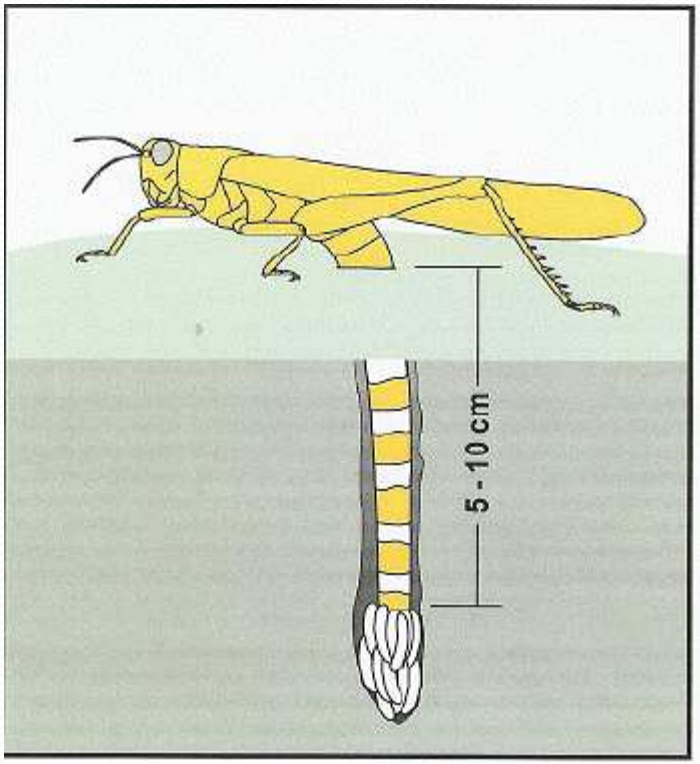
LDAS PROJECT : LOCUST COMPONENT
Activity I state of art some results



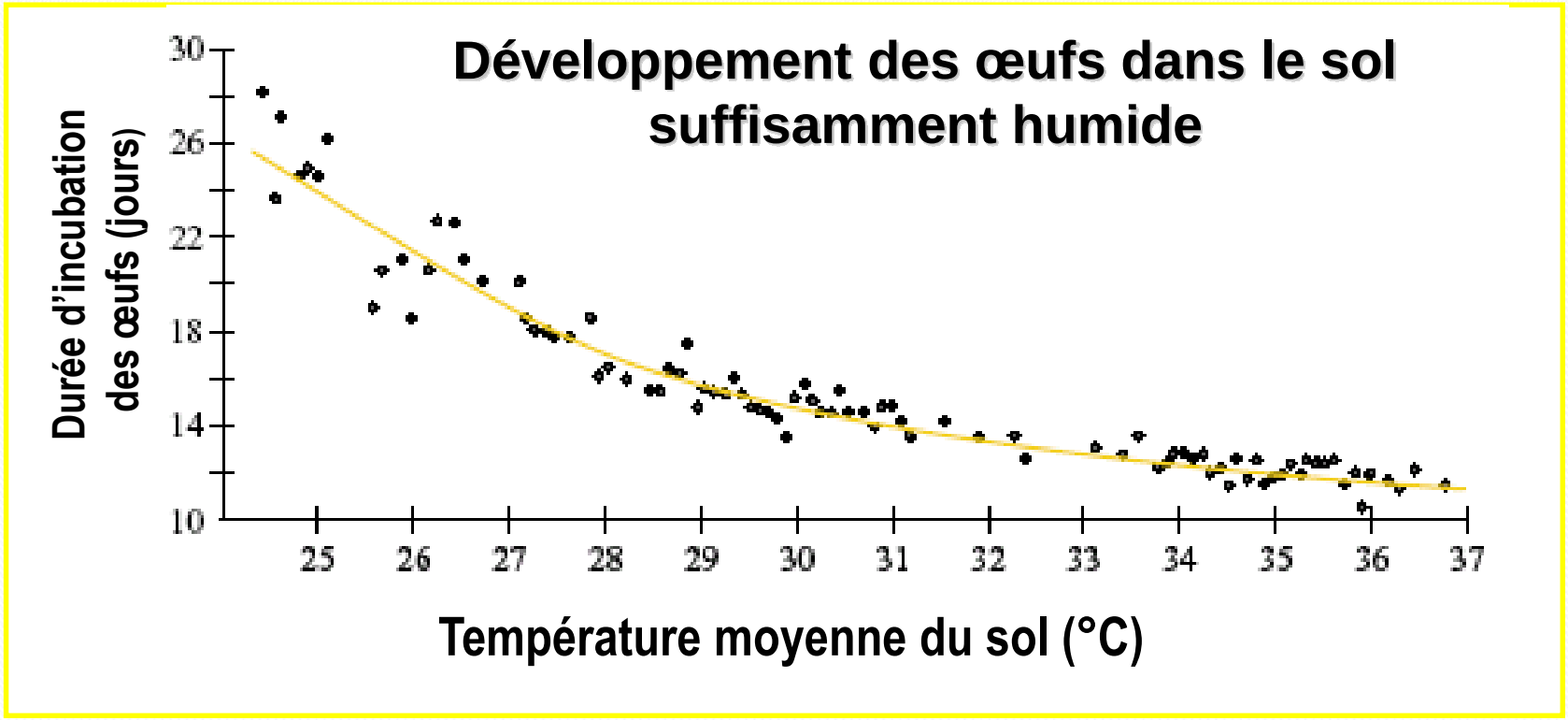
Desert locust biological life cycle
(FAO directives, 2001-2003)

Conditions of egg laying egge

- **sufficient moisture from 5-10 cm** under ground
- The rate of development depends on **soil temperature**
- The **wind exposure** can dry eggs
- **Floods** can kill eggs



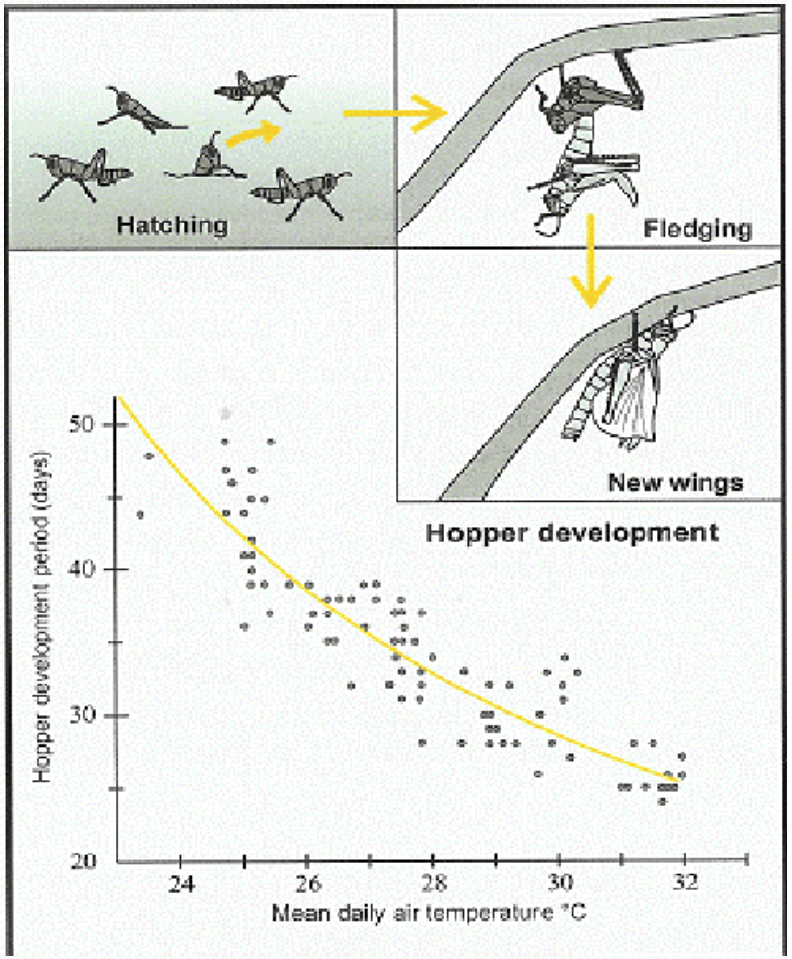
Incubation duration vs Land surface temperature



(Wardhaugh, Ashour *et al*. 1969, in Uvarov, 1977)

Maturation conditions

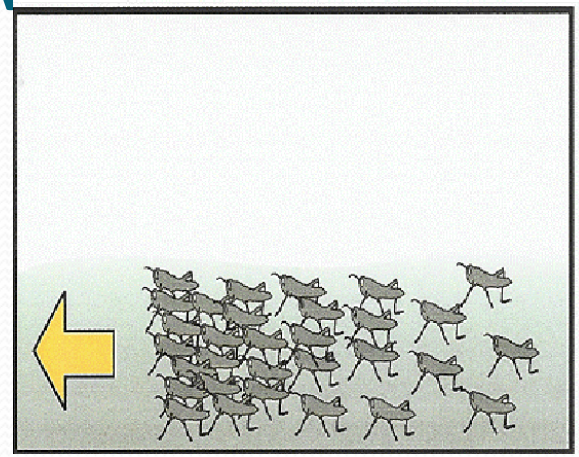
- Maturation duration for young hopper is shorter when the air temperature is between 24° and 32°C
- Vegetation cover is necessary for moulting



wing development

- Rain stimulate the developpement of wings
- Young adults are becoming more mature in the areas where a recent rainfalls episode occurs

Movement on the ground of hopper bands



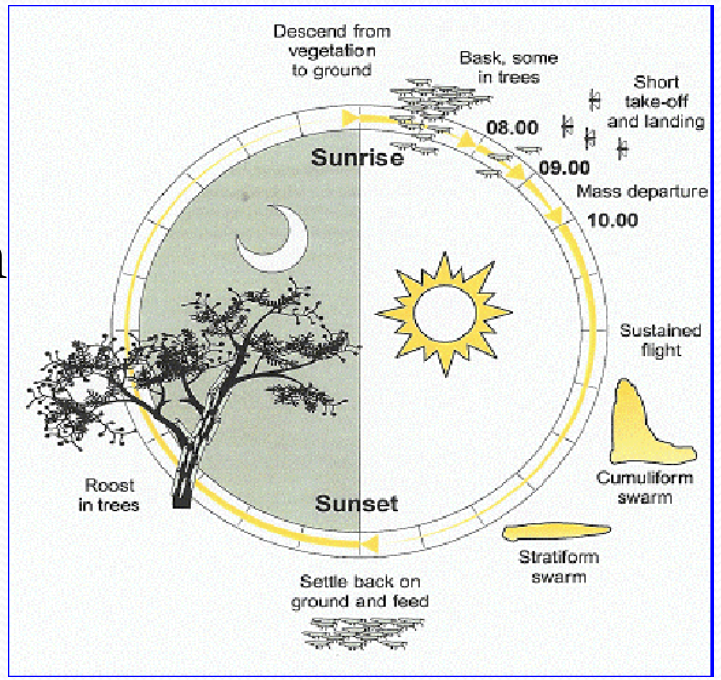
- Sunny and warm days : favorable conditions for walking bands the whole day
- Few movement in cloudy days.
- No walking in the night (except little displacement if the air temperature is very high)

solitary adults migration conditions

- migration begins usually 20 min after the sunset,
- temperature 20 to 22 °C
- wind speed < 7 m/s
- all adult locusts fly at temperatures above 27 ° C and below the wind

swarms formation and structure

- The extent of swarms can reach a few km
- The swarms structure depends on weather conditions :
  - Swarms in stratus form in cool and cloudy conditions
  - Swarms in cumulus form in ascending convective current.



LDAS PROJECT : LOCUST COMPONENT
Activity I state of art some results

swarms formation and structure

A

B

A swarm in cumulus form (photo CAE aviation, 2004)
B swarm in stratus form (photos T. Ben Halima, octobre 2004)

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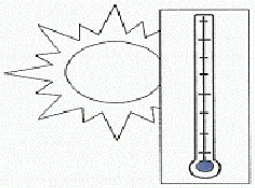
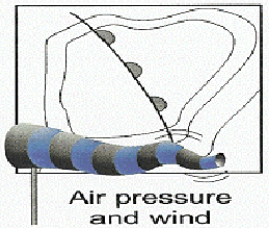
Activity I state of art some results

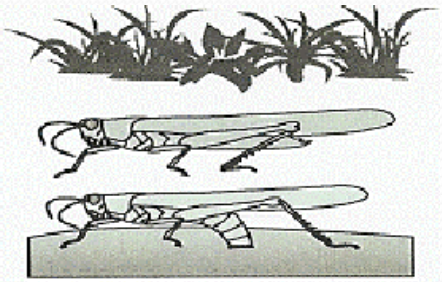
Meteorology and key stages

Rain and soil moisture

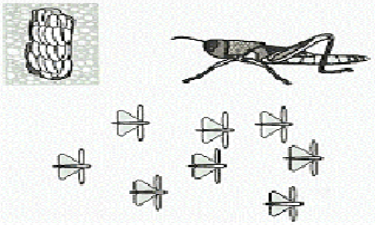


Air Temperature

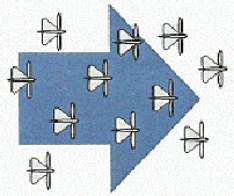




Green vegetation
Locust presence
laying eggs



Egg and first
development
stages



Migration and invasion

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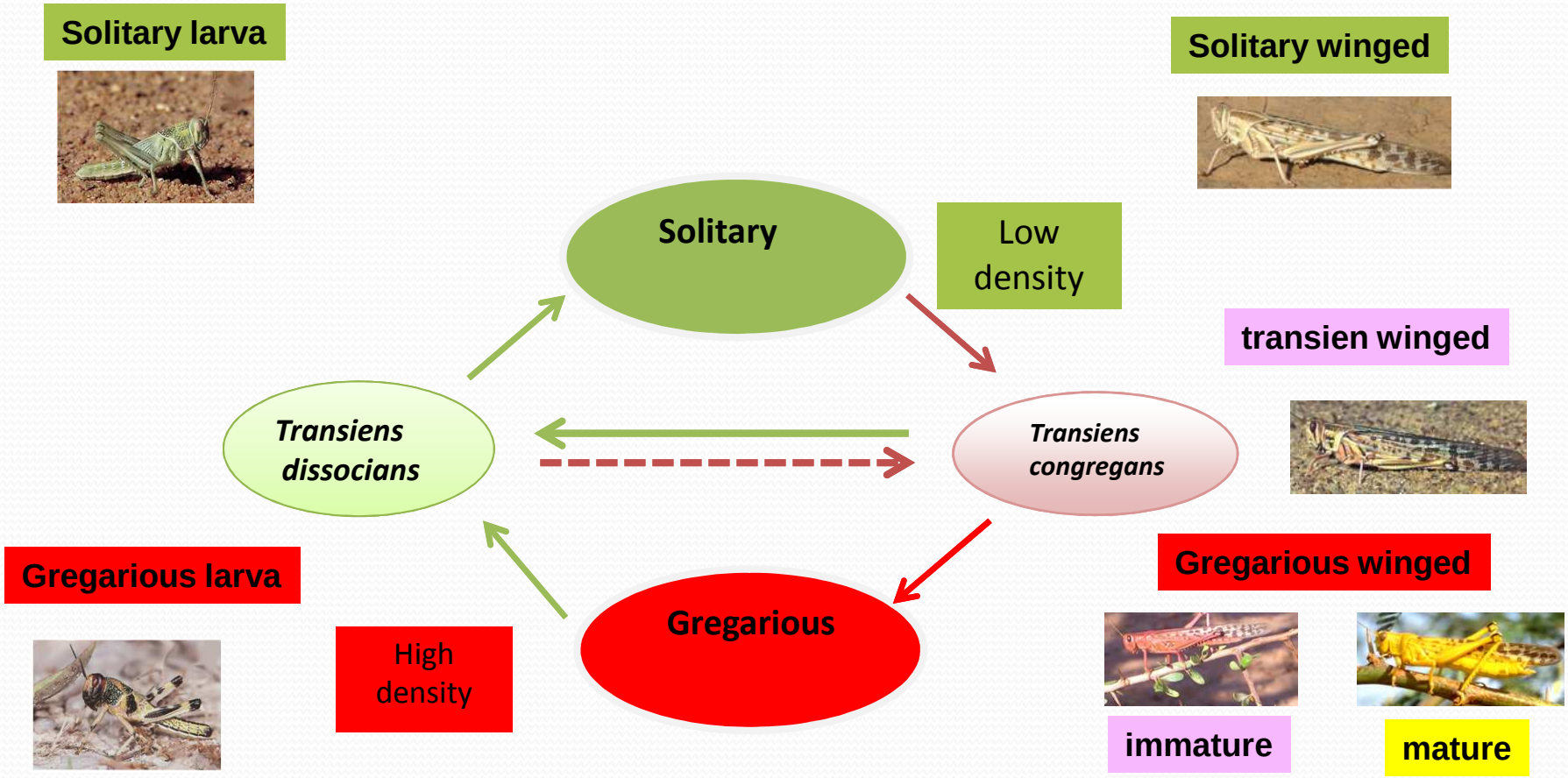
Activity I state of art some results

Behavioral change



Phasal transformation cycle

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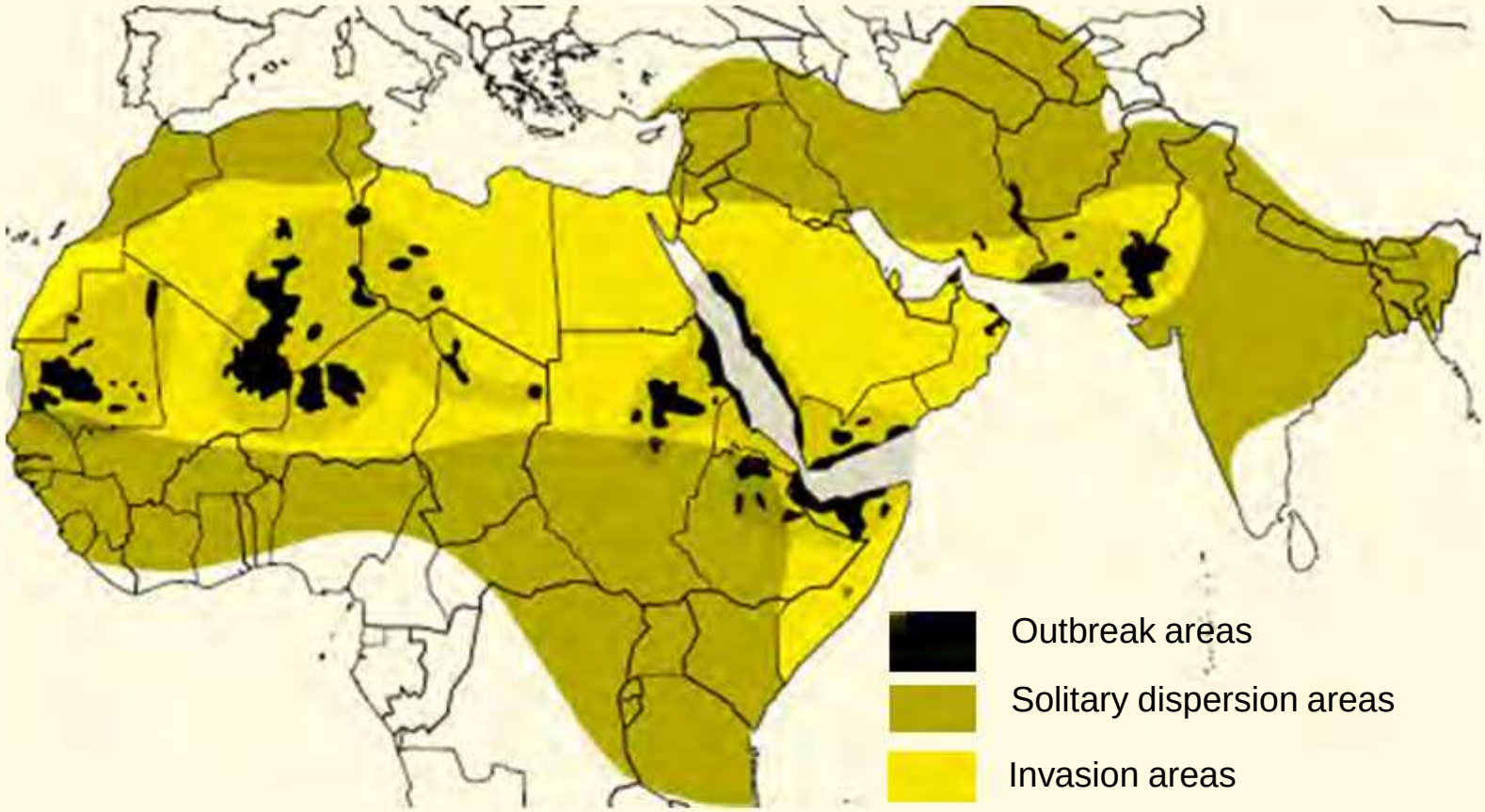
Activity I state of art some results

Outbreak areas



Locust outbreak areas from 1926 to 1976 (Waloff, 1976)

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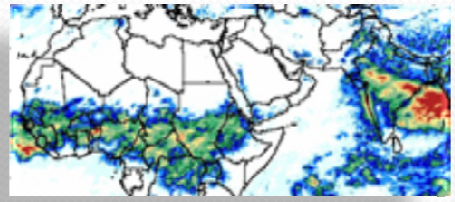
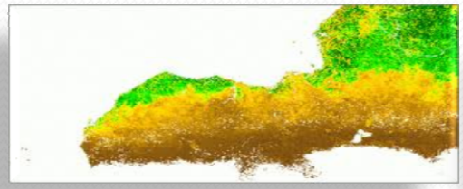
Activity I state of art some results

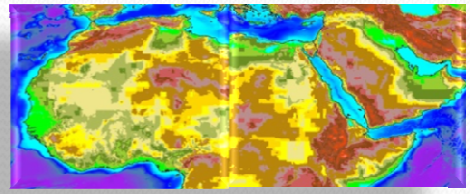
synthesis



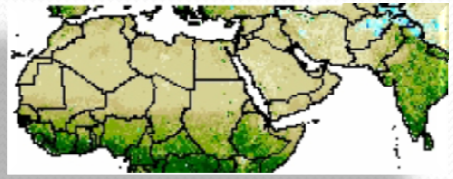
Precipitations



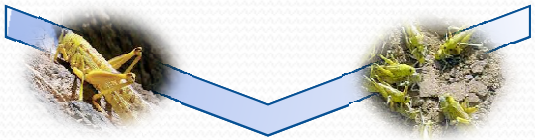
Land Surface Temperature

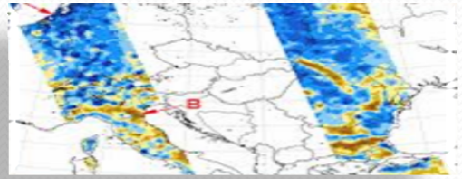


Air Temperature

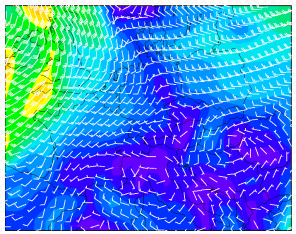


Vegetation indices





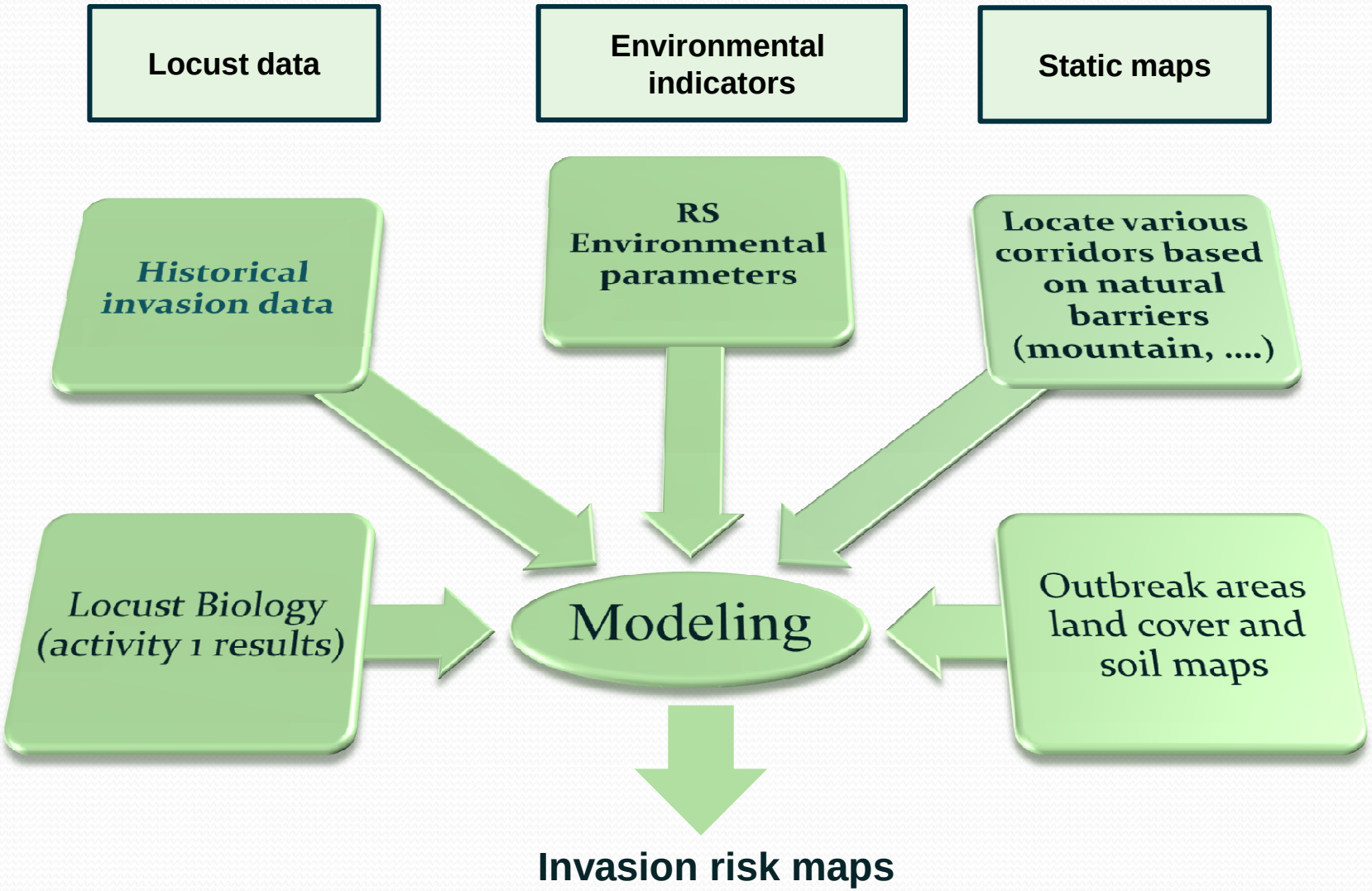
Soil moisture



Wind

LDAS PROJECT : LOCUST COMPONENT
Activity 3 : locust invasion risk assessment system

Methodology



LDAS PROJECT : LOCUST COMPONENT
Activity 3 : locust invasion risk assessment system

Collecting data (ongoing)

Historical locust invasion data	Indicators						Cartography
	Precipitation	Vegetation	LST	Soil Moisture *	Wind	meteor ology	
FAO (campagnes précédentes de luttes anti acridiennes)	TRMM DMN	MODIS	MODIS	LIS / ASCAT	Eumet Sat	MPEF NOAA	Aster Global Digital Elevation Map (30 m) Land cover from DEIMOS or Landsat

LDAS PROJECT : LOCUST COMPONENT
Activity 3 : locust invasion risk assessment system

Prospection data transmition system Elocust2

Elocust2 is a tool developped by Novacom for FAO

communicate in real time prospection data

LDAS PROJECT : LOCUST COMPONENT
Activity 3 : locust invasion risk assessment system

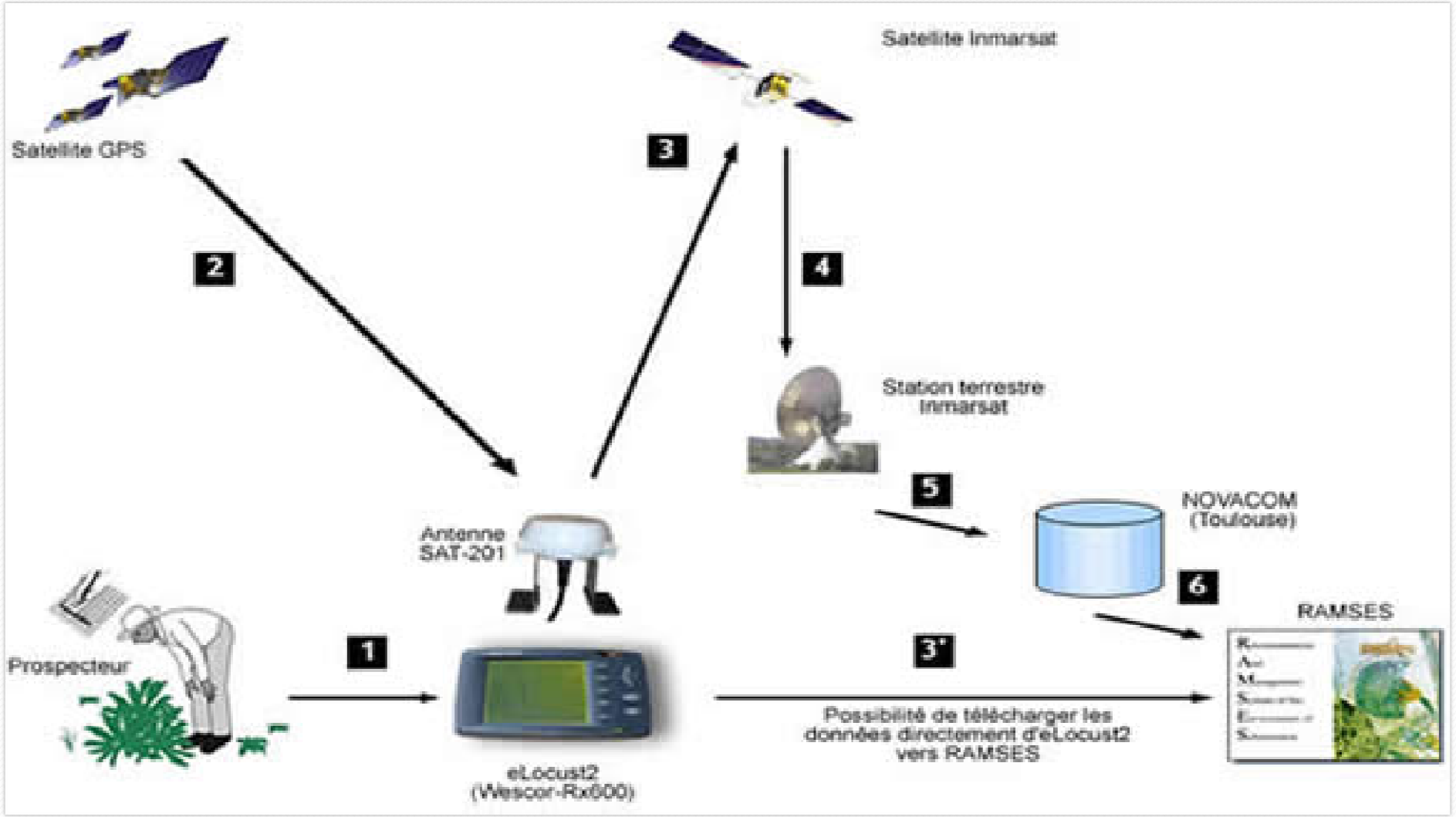
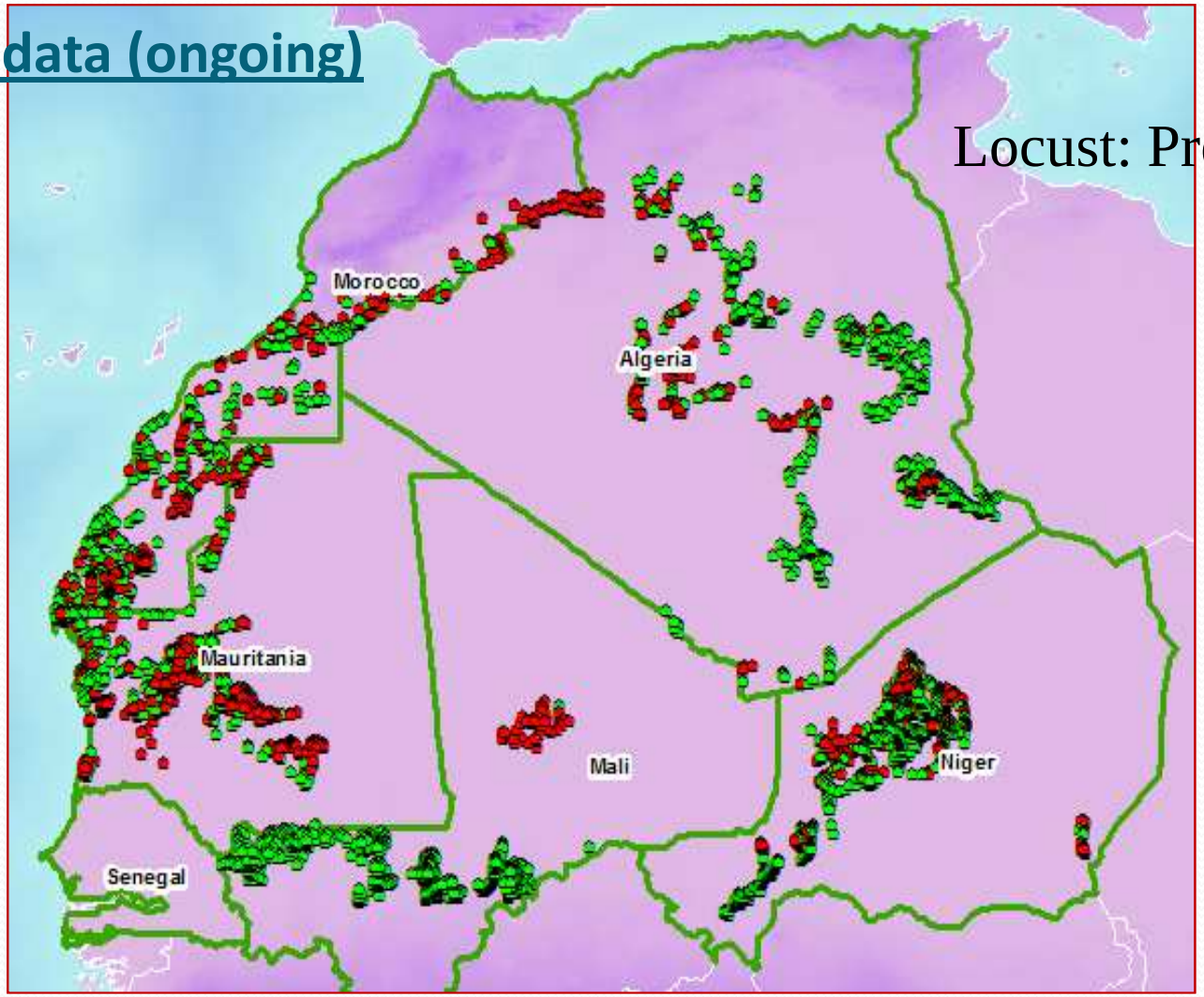


Schéma général de fonctionnement et d'utilisation d'eLocust2

LDAS PROJECT : LOCUST COMPONENT
Activity 3 : locust invasion risk assessment system

Collecting data (ongoing)



Prospection Data octobre 2012 to march 2013

LDAS PROJECT : LOCUST COMPONENT
Activity 3 : locust invasion risk assessment system

Collecting data (ongoing)

Locust : behavior

Prospection Data octobre 2012 to march 2013

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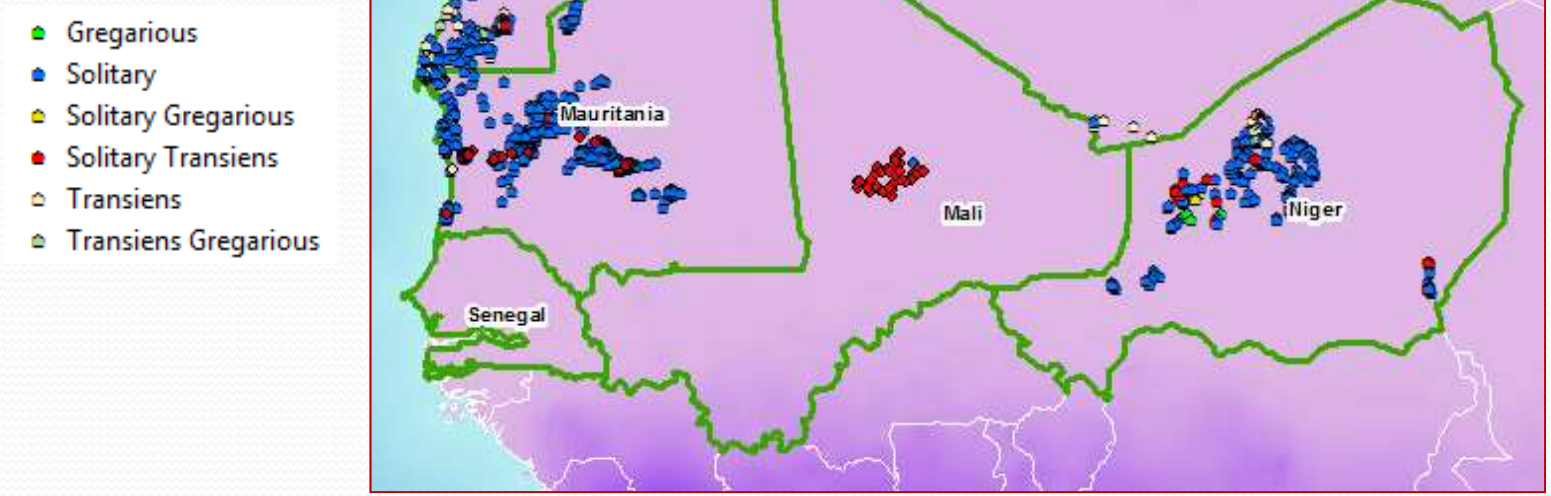
Collecting data (ongoing)



Locusts : Phases

Prospection Data octobre 2012 to march 2013

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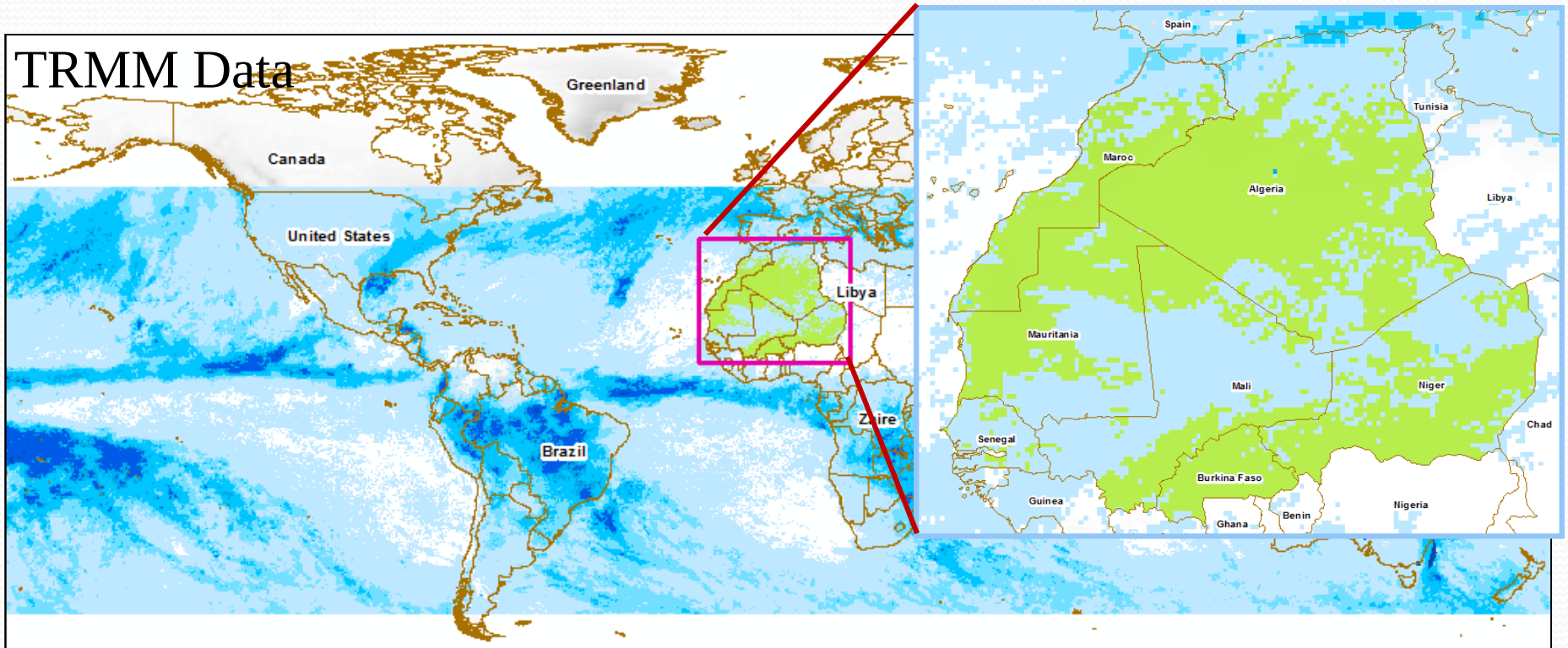
Activity 3 : locust invasion risk assessment system



Caractérisations du TRMM 3B42	
Temporal Coverage	Start Date: 1998-01-01; Stop Date:
Geographic Coverage	Latitude: 50°S - 50°N; Longitude:180°W - 180°E
Temporal Resolution	3-Hourly
Horizontal Resolution	0.25° x 0.25°; nlat = 400, nlon = 1440
Average File Size	Compressed: ~0.71 MB; Original: ~11 MB
File Type	HDF

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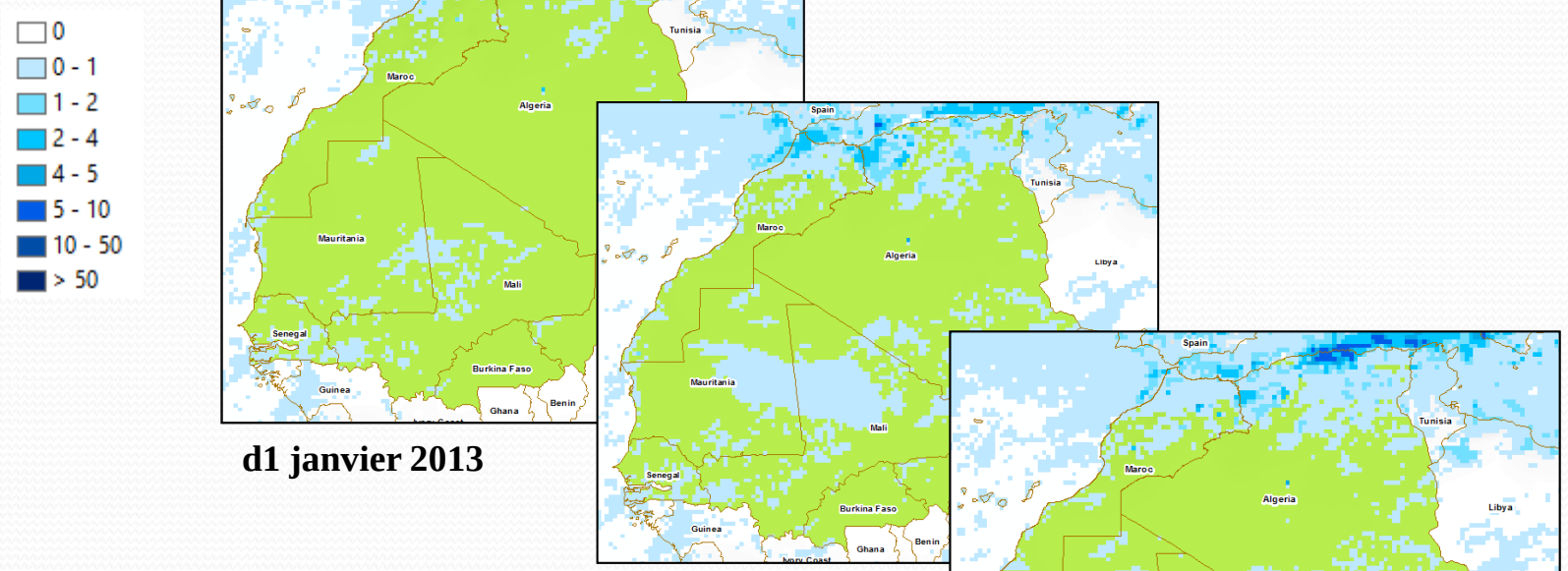
Collecting data (ongoing)

TRMM Data

01 Janvier 1998 → 31 Mars 2013



d1 janvier 2013

d2 janvier 2013

d3 janvier 2013

- Journaliers
- décadaires
- Mensuelles

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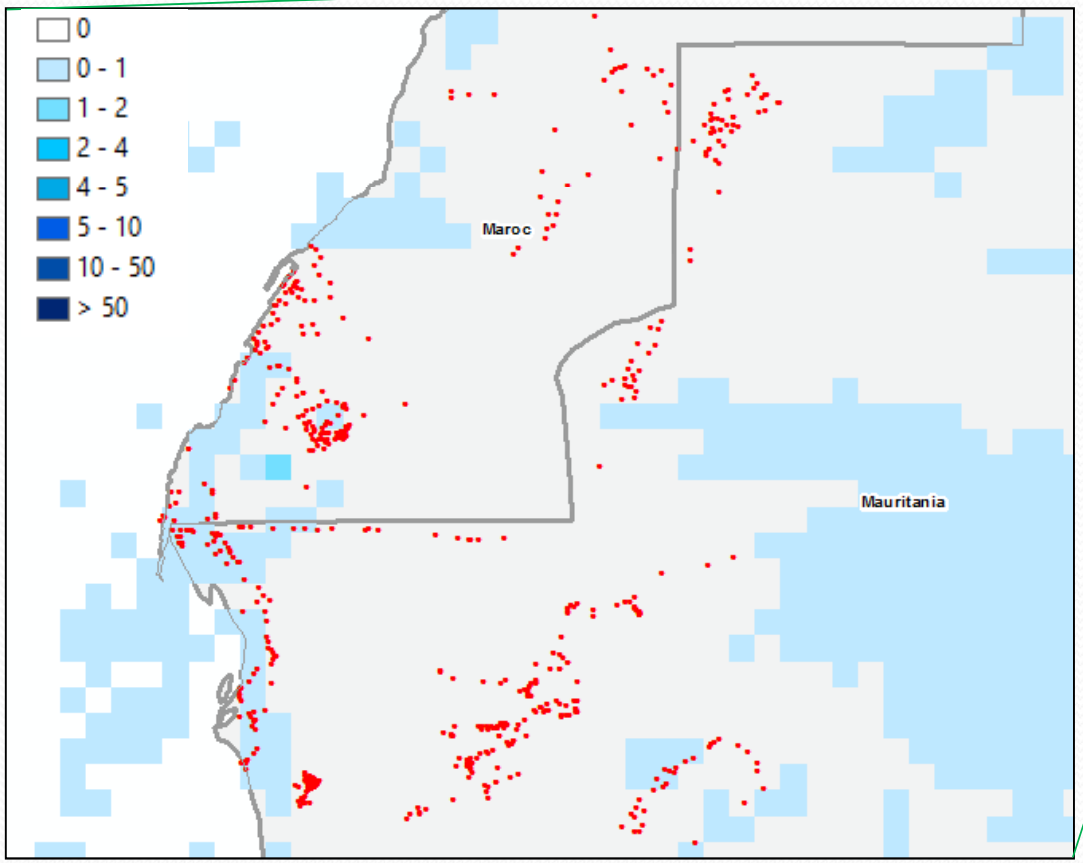
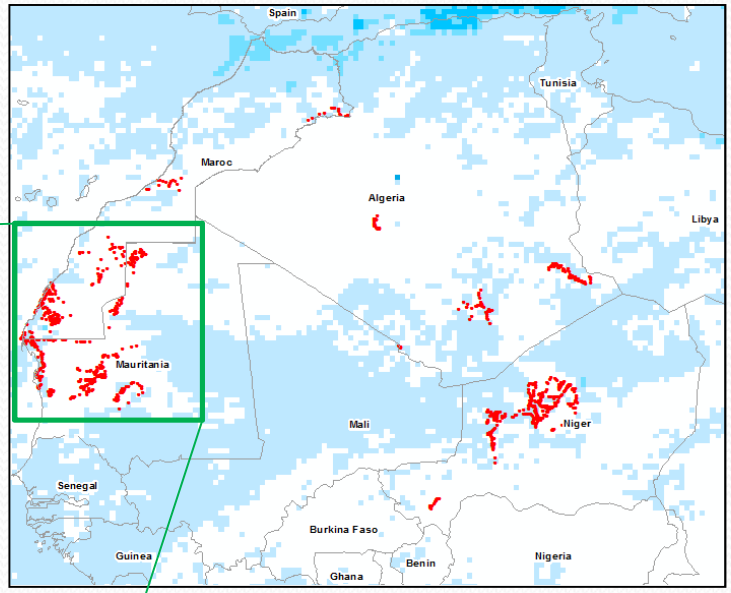
Activity 3 : locust invasion risk assessment system

Collecting data (ongoing)

TRMM / Locust

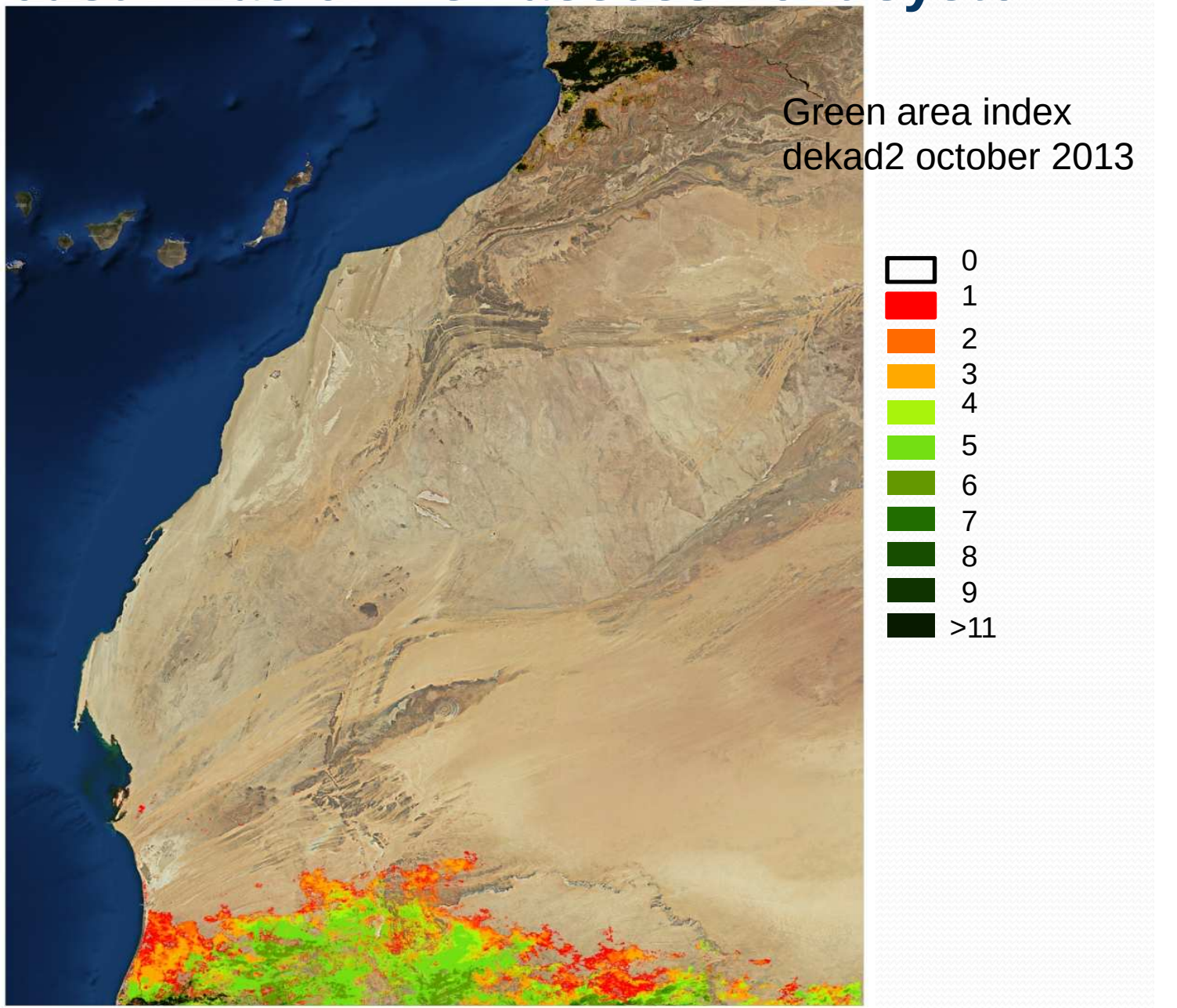
Janvier 2013





Locusts groups Presence vs
Monthly mean precipitation

LDAS PROJECT : LOCUST COMPONENT
Activity 3 : locust invasion risk assessment system



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Next step

- Modeling activity : international expert recrutment (in progress)
- Soil moisture production tool : international expert recrutment (in progress)
- Model implementation : national expert (after modeling expert results)
- Capacity building activities :
  - Hydrosat course at ITC Nethelands (3 weeks)
  - webmapping course
  - FAO Visite (DLIS , collect historical Data, futur collaboration)

modeling TDR summary

missions	activities	delivrables
Choice and setting up of models of the different stages of locust invasion.	• environmental conditions expertise results analysis • Models identification • historical and environmental data base and land prospection data collection; • Develop estimation methods of risk invasion bases on such a data; • Define validation process	Report Structured prospection Data base
team in charge of model implementing assistance	• tools, data and implementation methods of models specification; • simulation a prototype of the defined model • TDR of implementation consultantance • Assist the team in implementation;	technical specifications of the implementation of model Prototype training

soil moisture TDR summary

missions	activities	delivrables
Review of the existing methods on soil moisture estimation from RS	• Existing methods description of the existing methods, satellite data needed and the necessary tools for its production; • Choice or elaboration of the best method o Justify the efficiency of the method and compare with used in LIS o necessary data o required validation method(s); o hardware and software needed implementation.	• Review report on the existing methods and a justification for the chosen method; • Hardware and software specification document for the implementation; • Implementation plan
Implementation of the Application "Soil moisture Assessment from Satellite Data"	• implementing the chosen method • Test the application • Provide the application's installation manual; • Provide the application's user manual; • Train the project team on how to use the application	• Soil moisture application set up in CRTS; • report on the application tests; • installation manual guide • users manual guide • training session

Hope good results on time

Thank you for attention