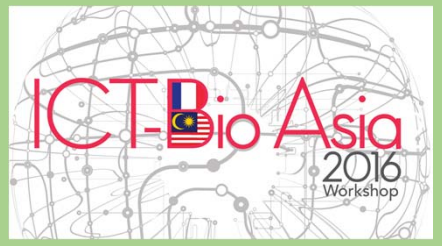


Wireless Sensor Network based Monitoring, Cellular Modeling and Simulations for Environment

Onil Nazra Persada Goubier, Hiep Xuan Huynh,
Tuyen Phong Truong, Mahamadou Traore
and the SAMES group

United Nations Educational, Scientific and Cultural Organization

AKADEMI SAINS MALAYSIA

MOSTI
KEMENTERIAN SAINS, TEKNOLOGI DAN INOVASI

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DES AFFAIRES ÉTRANGÈRES ET DU DÉVELOPPEMENT INTERNATIONAL

leFRENCHFESTIVAL

Malaysia France University Centre
Centre Universitaire Franco-Malaisien

UNIVERSITY OF MALAYA

SAMES Group

- SAMES (Stic Asia Modeling for Environment and Simulation) Group
  - Researchers
    - France:
      - University of Bretagne Occidentale / LabSTICC as leader (B. Pottier, V. Rodin, B. Nsom, L. Esclade), CIRELA Paris (O. Goubier) IRD Paris (S. Stinckwich)
    - Vietnam:
      - Cantho University (HX Huynh, BH Lam), IFI Hanoi (Vinh)
    - Indonesia
      - BPPT Jakarta (Udrekh, Hafidz Muslim), DRR Foundation Indonesia (Surono)
  - Objectives:
    - to develop software tools to ease wireless distributed sensing and data integration in relation with critical physical processes.

Physical Phenomena

Physical Phenomena:

- water flow, flooding, pollution, volcano, insect invasion, ...

Environment Issues

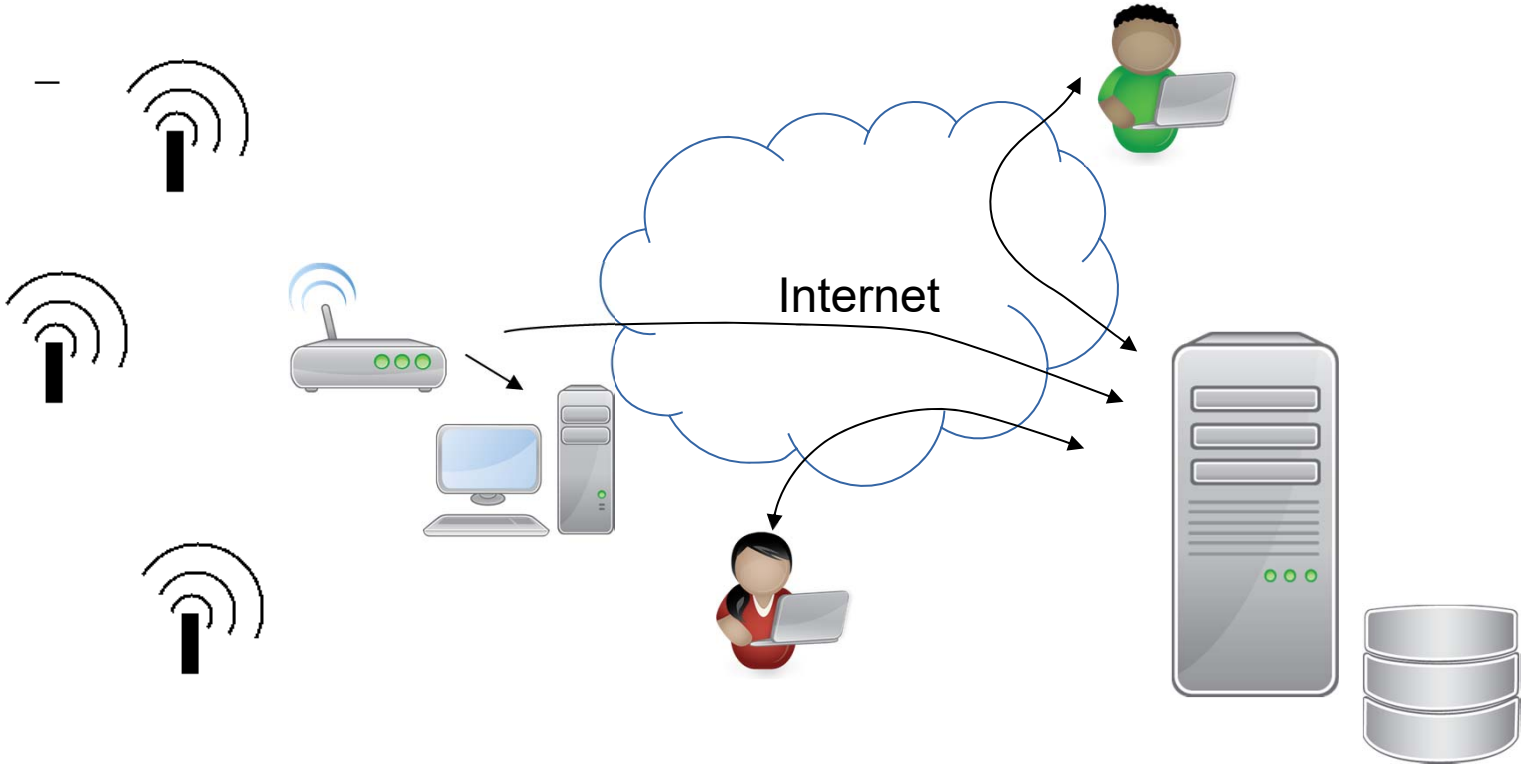
- Environment and climate change issues
  - Reduce Risks of natural and environmental disasters
  - Knowledge on physical phenomena
  - Real time monitoring
  - Life in harmony with the environment

Plan

- Wireless Sensor Networks, an overview
- Geo-localized Cellular Modeling and Simulation
  - PickCell/Netgen modeling tools
- 2 cases:
  - Line of sight
  - Desert locus invasion
- Current cooperations
- Potential cooperations

Wireless Sensor Networks

- Wireless Sensor Networks



Wireless Sensor Networks

- A WSN measures values representing the state of a physical system
  - Distributed measurements for physical phenomena
  - Space and time
- Sensors:
  - Measure values,
  - ex. flood monitoring and warning:
    - water level, flow rate, ...

Wireless Sensor Networks

- Networks
  - mesh, hierarchical, ...
  - ZigBee, SigFox, LoRa, Cellular IoT, LTE-M, GPRS, …
  - Low cost, low power and low rate communication

Wireless Sensor Networks

- Information System (IS)
  - Collected data to IS → Database server
  - External sources
- Data used to:
  - Monitoring, Modelling, Simulation, Forecasting, Decision Support
- Dissemination:
  - Web technology, handphone applications

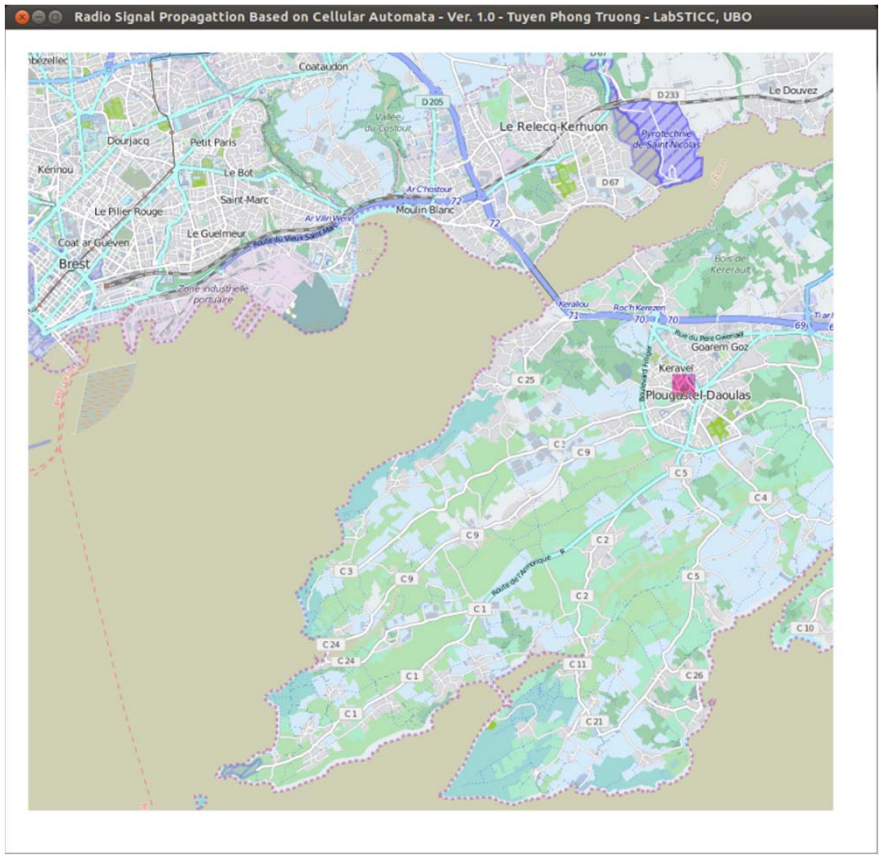
Geo-localized Cellular Modelling

- Cellular model to study a physical phenomenon and measures taken from a WSN from the same geographical area
- Coverage:
  - Sensor locations
  - Number of Sensors
  - Periodicity

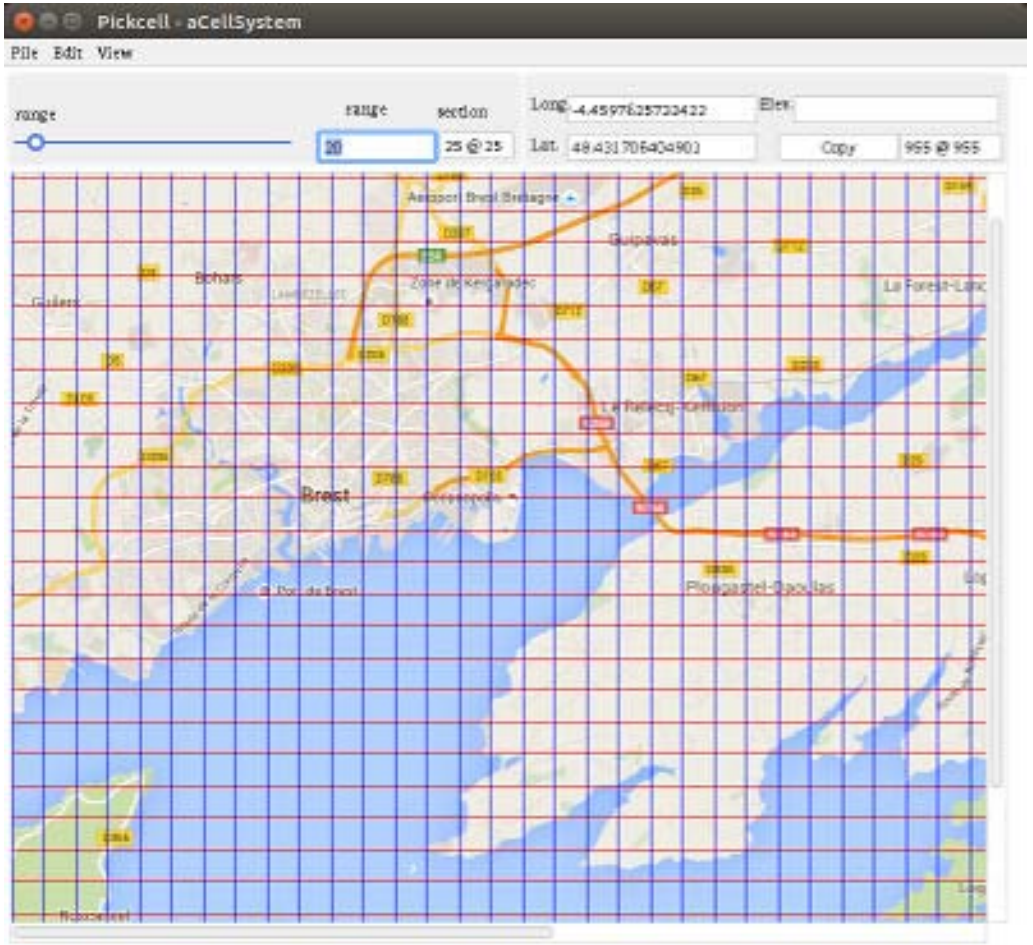
Geo-localized Cellular Modelling

- Represent a physical phenomenon
- Physical evolution of this phenomenon
- Interaction between a physical phenomenon and a WSN

PickCell

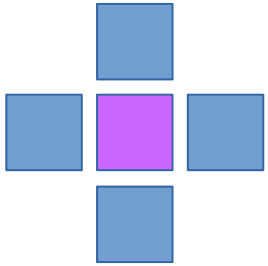

Radio Signal Propagattion Based on Cellular Automata - Ver. 1.0 - Tuyen Phong Truong - LabSTICC, UBO
Coataudon
Le Douvez
Le Relecq-Kerhuon
Dourjacq
Petit Paris
Kerinou
Le Bot
Saint-Marc
Le Plier Rouge
Moulin Blanc
Le Guelmeur
Coat ar Gueven
Brest
Goarem Goz
Keravel
Plougastel-Daoulas

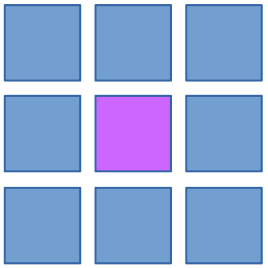
PickCell


Pickcell - aCellSystem
File Edit View
range
range
section
25 @ 25
Long -4.459762572342 2
Elev
Lat 48.431706404901
Copy
955 @ 955
Brest

PickCell

- Cellular Automata
  - A cell represents a local state of a physical phenomenon
  - System evolution is based on neighborhoods :
    - Von Neumann or Moore

Von Neumann 

Moore 

  - Communication between cells
  - Rules describes how a cell changes at each time step

Line of Sight Computation

- Problems:
  - how to manage sensors deployments to overcome physical constraints and to get better coverage
    - And reduce cost!
  - How well sensor networks can sense a physical phenomena in an area → network sensing coverage
- Collective measures:
  - Sensor positions, number, precision
  - Radio propagation,
  - Radio technology
  - Ground contour, ...

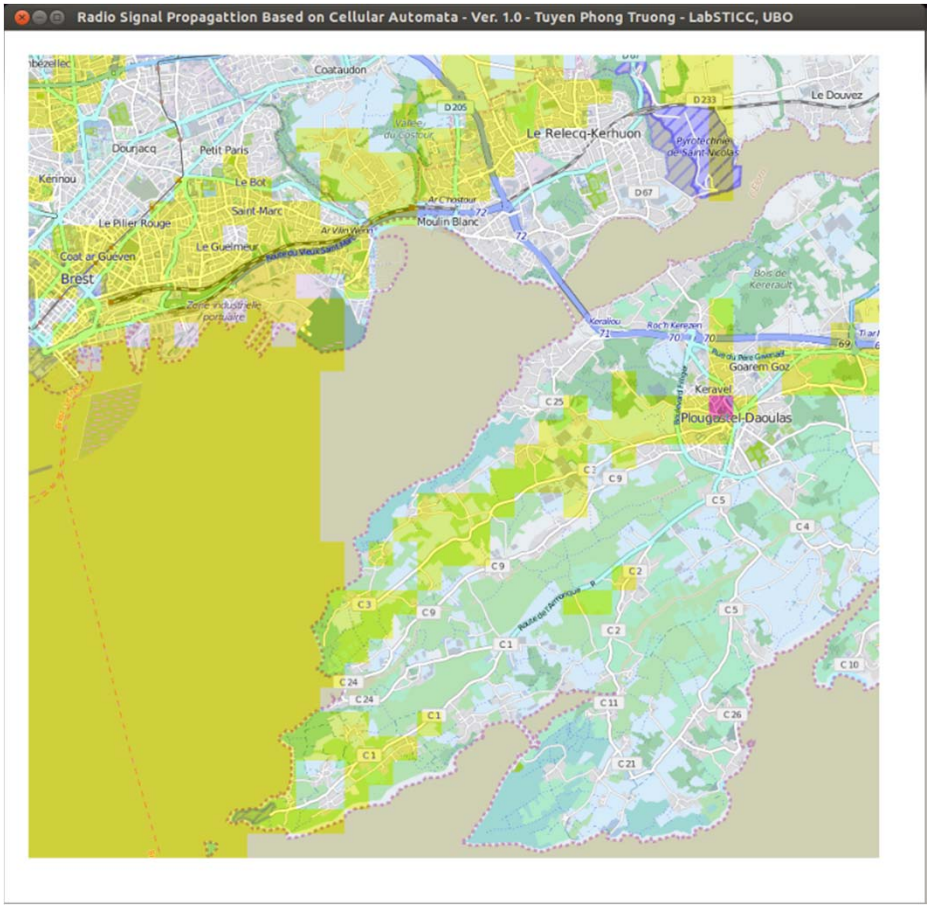
Line of Sight Computation

- Radio propagation
  - a physical phenomenon
  - a logical connectivity between nodes (in cell system).
- Radio propagation can be stopped or attenuated by ground topology (hills, valley).
  - Free Space Path Loss Model
  - Model with Diffraction

Line of Sight Computation

- Simulate the physical behaviour by :
  - propagating the signal inside a tree rooted at the emitter cell,
  - and covering all the space in concentric circles.
- During radio propagation,
  - the ground profile is collected into routes that are completed progressively based on positions and elevations.
  - Each cell decides if the emitter is visible or not by comparing its elevation to the received profile.

Line of Sight Computation



United Nations Educational, Scientific and Cultural Organization

Malaysia France University Centre
Centre Universitaire Franco-Malaisien

UNIVERSITY OF MALAYA

Line of Sight Computation

- Still much work to be done
- More parameters to take into account :
  - More obstacles
  - Number of sensors, locations
  - Radio technology : LoRa, ZigBee, …
  - ...

Desert Locust Invasion

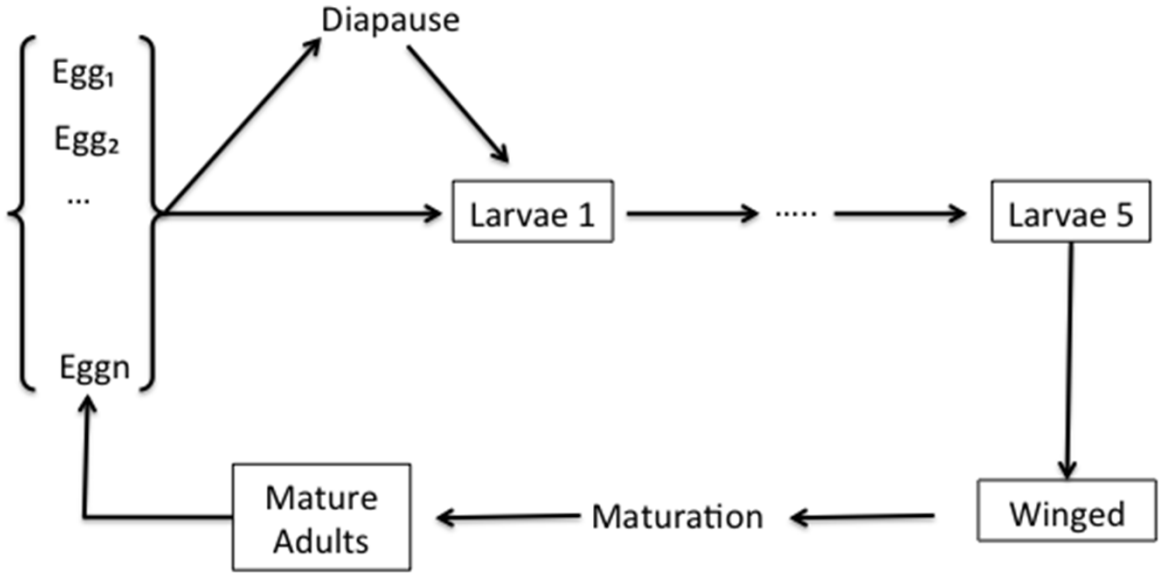
- Research with Senegal and Madagascar
- Desert locusts change their behavior, physiology and morphology, in response to density variations.
- This change happens on short time and space scales preferentially in breeding areas known as locusts invasion starting point
- Two different behavioral phases:
  - Solitarious :
    - individuals live in a sparse and scattered manner in Sahel countries
    - do not venture and do not affect agricultural production.
  - Gregarious :
    - responsible for considerable damage caused to crops

Desert Locust Invasion

- Outbreaks happen only within specific conditions, leading to huge swarms, trying to survive by flying for other food sources and for escaping predators.
- They migrate from one area to another for a better living condition, and die if they fail to find a suitable breeding area.
- Emigration concerns winged individuals who turn to solitarious and then to gregarious before flying in a swarm.

Desert Locust Invasion

- Desert locust physical system:
  - the locust population in their breeding area and their interactions with weather, vegetation cover and wind, evolving from eggs to adults and flying to other cells, laying eggs.

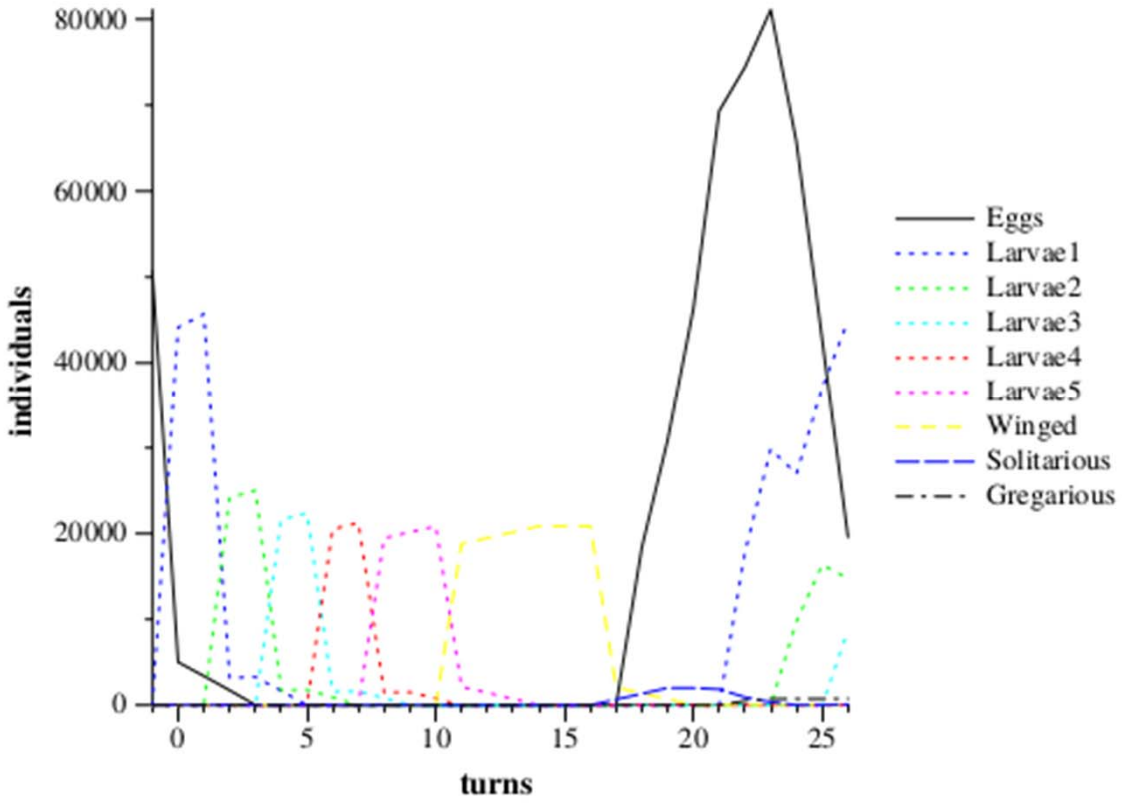


Desert Locust Invasion

- Cell model:
  - each cell contains
    - eggs, larvae stages 1 to 5, winged, solitarious and gregarious individuals.
  - Each array is subdivided in micro states representing the corresponding individuals life cycle period.
  - Two cases:
    - local transition between micro states in a cell.
    - migration between cells

Desert Locust Invasion

- Local transition between micro states in a cell

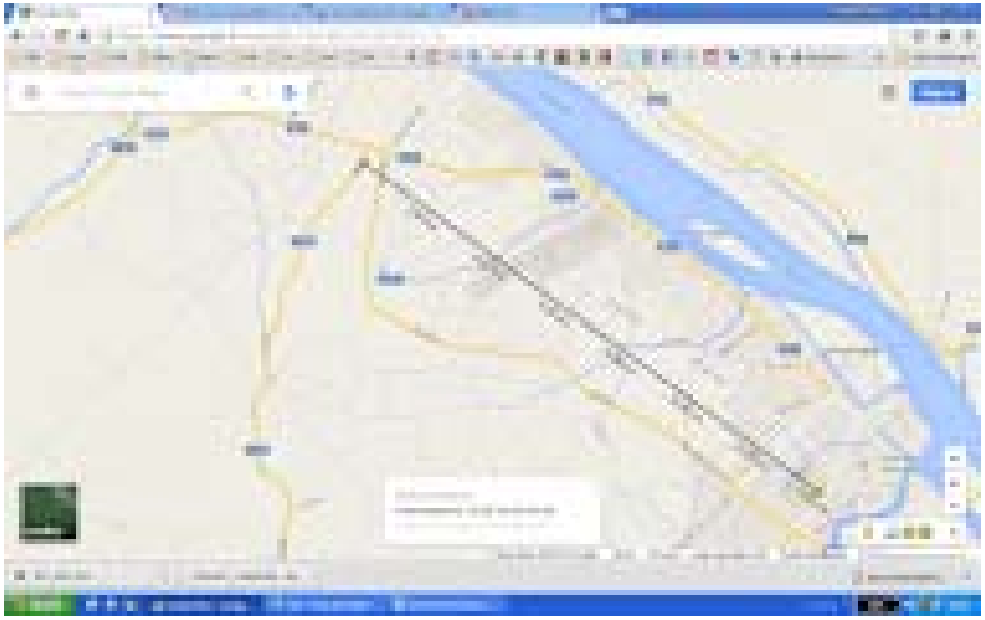


Desert Locust Invasion

- Work still in progress
  - Migration of locusts
  - More parameters :
    - Weather, wind, vegetation cover, …
    - Geo-localized with WSN
    - …

Current Cooperation

- Experimentation with LoRa in Vietnam



Current Cooperation

- Experimentation with LoRa in Vietnam

Current Cooperation

- Experimentation with XBee in Indonesia

Current Cooperation

- Experimentation with XBee in Indonesia

Current Cooperation

- Next :
  - Apply line of sight computation for Indonesia and Vietnam examples
  - More applications:
    - Modeling floods : Indonesia, Vietnam, ...
    - Modeling insect invasion :
      - Vietnam, Senegal, ...

Next?

- Many cases and applications in environment, in case of green smart cities
- We are open to cooperation with additional partners

SAMES

Thank you
Merci
Cảm ơn
Terima kasih