FruitFlyNet

A Location–aware System for Fruit Fly Monitoring and Pest Management Control

FruitFlyNet prototype: The case of olive fly

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The project FruitFlyNet total budget is 1.662.872,32€ and it is financed, on an amount of 1.496.585,09€ (90 %), by the European Union (ENPI CBC Mediterranean Sea Basin Programme) through the European Neighbourhood and Partnership Instrument.

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Bactrocera (=Dacus) oleae, the Olive Fruit Fly

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Bactrocera oleae

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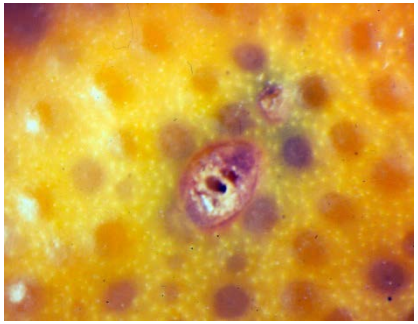
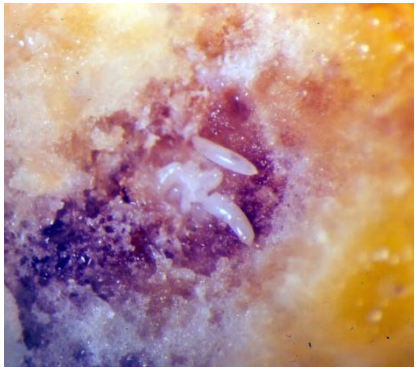
Ceratitis capitata, the Medfly





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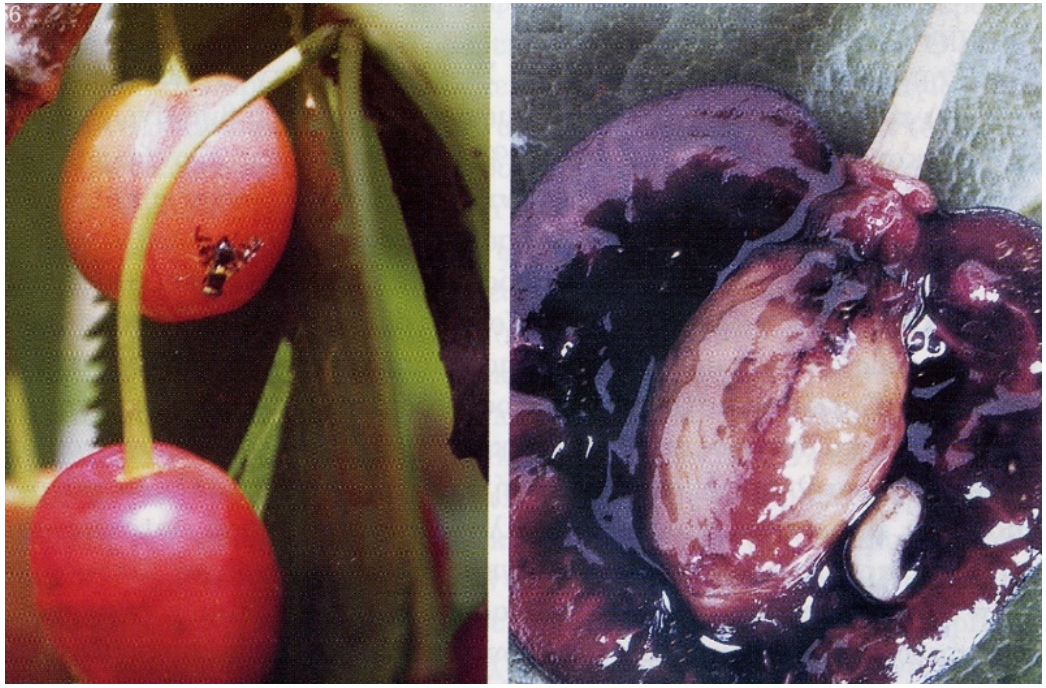
Rhagoletis cerasi, the Cherry Fruit Fly



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Bactrocera zonata, Dacus ciliatus Invasive Fruit Flies

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What makes the FRUITFLIES major pests?

Direct damage on the fruit close to maturation	High risk for economic damage Timely application of insecticides Difficulties in the use of insecticides (PHI – residues in the fruit)
Develop in the fruit	Less efficacy by pesticides but also predators and parasitoids
Mobility/invasiveness	Monitoring essential on real time basis
Extended monoculture in large areas	Difficulties in the application of control strategies / precision in monitoring and spraying
Ecological adaptation	High reproductivity, alternative host plants and food sources
Resistance to chemicals	Resistance has been commonly reported

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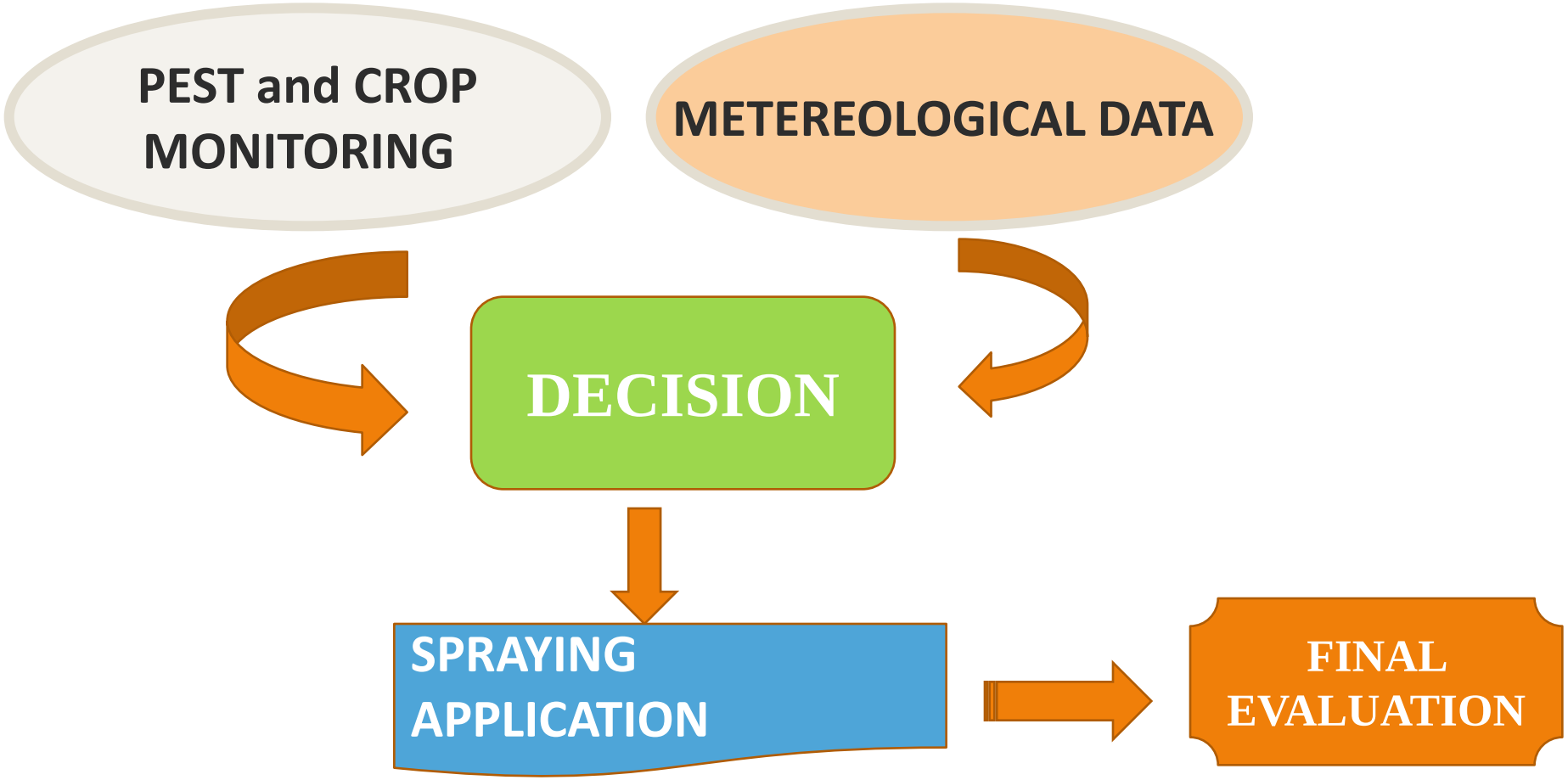
STRUCTURE OF PEST CONTROL SCENARIO



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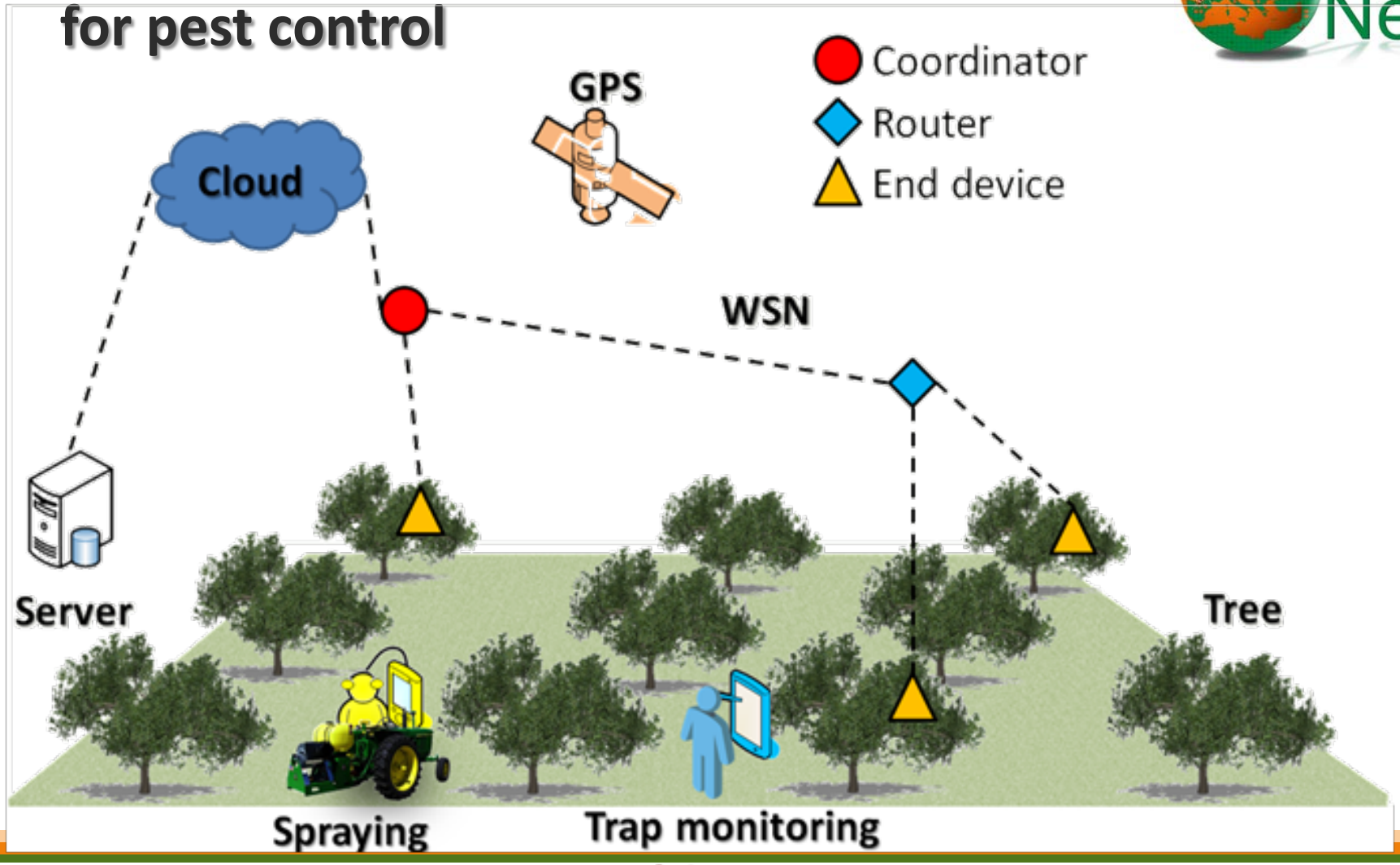
The Location – Aware System (LAS) for pest control



LAS architecture

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FRUIFLYNET EXPERIMENTATION

AIM: Develop the Location Aware System (LAS) and compare with the standard (NoLAS)

DESIGN: Use of randomized complete blocks (LAS, Standard, Control plots)

DEVELOPMENTS : E-traps, databases, Decision Support Systems, software, web services

OPERATION: Monitoring - Network of sensors, Spraying – software, web services

EVALUATE - COMPARE: SPRAYING - INDICATORS (spraying volume, number of spray applications etc).

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Components to compare: Standard (NO LAS) and Location Aware System (LAS)

STANDARD TREATMENT	VS.	LAS
Trapping, sampling	PEST MONITORING	Trapping-sampling, **direct recording,** + *use of traps with camera*
Single sensor	METEREOLOGICAL DATA	**Network** of sensors, **interpolation** in large areas
Manually operated	DECISION	**Computer assisted, scale of risk, real time** warning
Empirically based	SPRAYING APLICATION	**Location awareness:** variety, fruit load, pest and meteorological data interpolation, protected areas, controls the spraying volume, tracking

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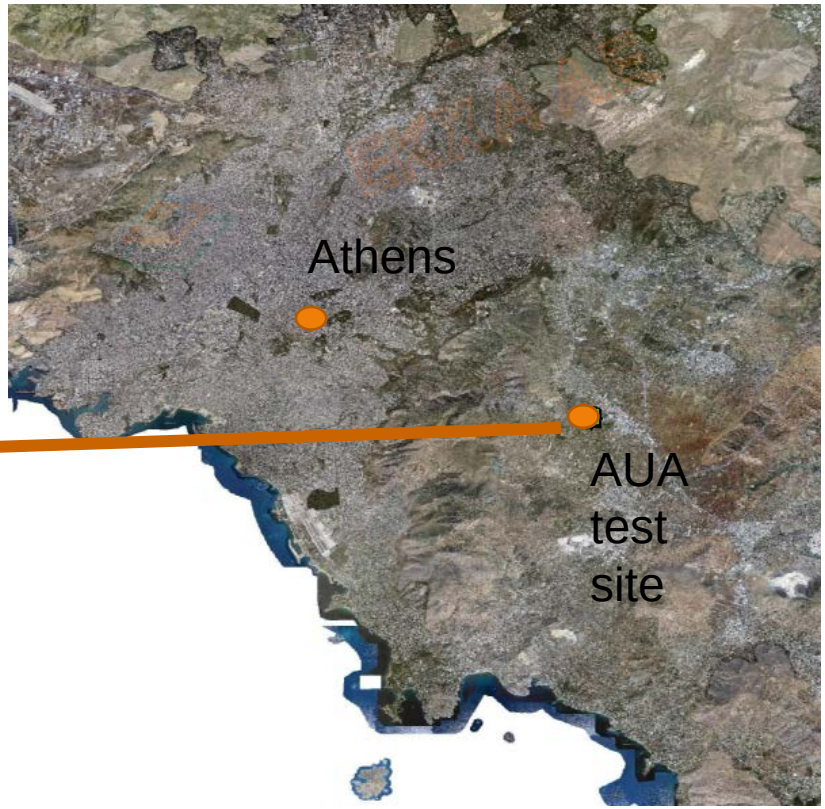
AUA TEST SITE



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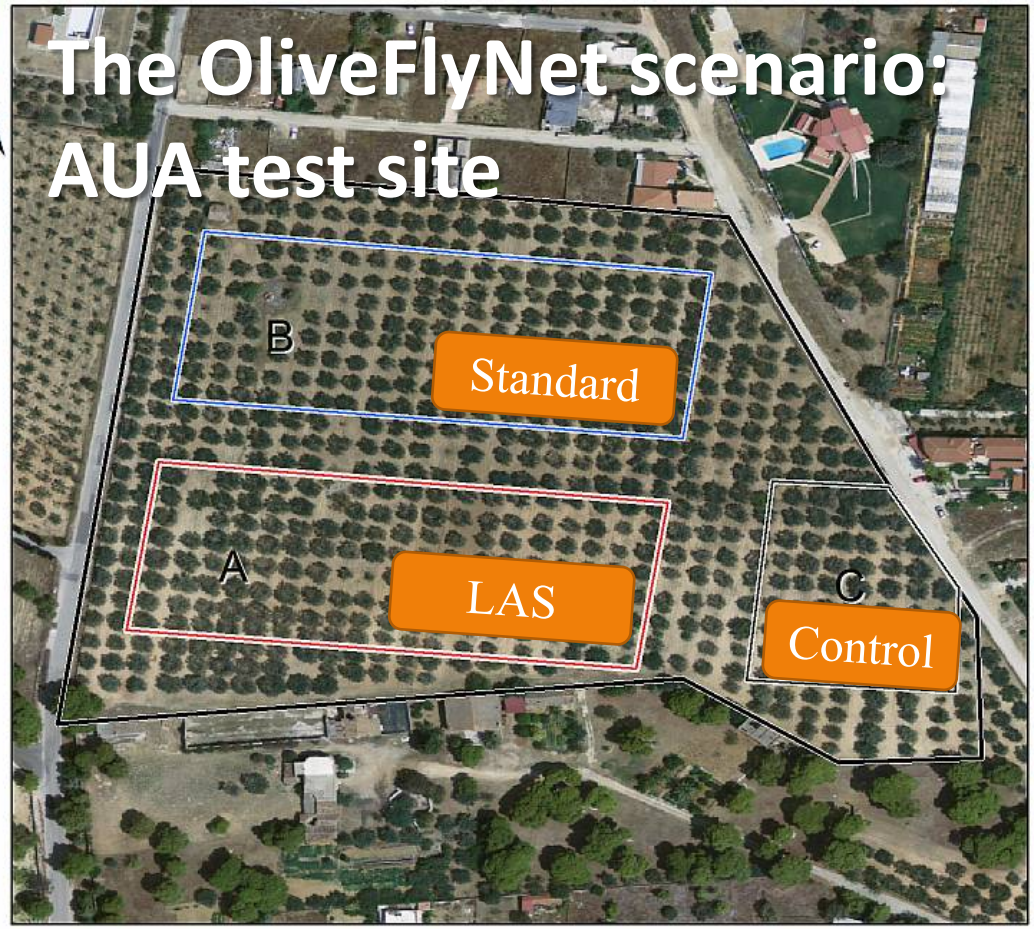
The OliveFlyNet scenario: AUA test site



1. EXPERIMENTAL plots - DESIGN

- SAME PLOT SIZE/SHAPE
- EQUAL NUMBER of TREES
- BUFFER ZONE
- NEIGHBORING CROPS

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2. ORCHARD DETAILS

- **SINGLE VARIETY (or varieties of similar susceptibility to the fruitfly tested)**
- **Plots UNIFORMLY cultured:**
  Tree age, height, fertilization, irrigation, pruning etc

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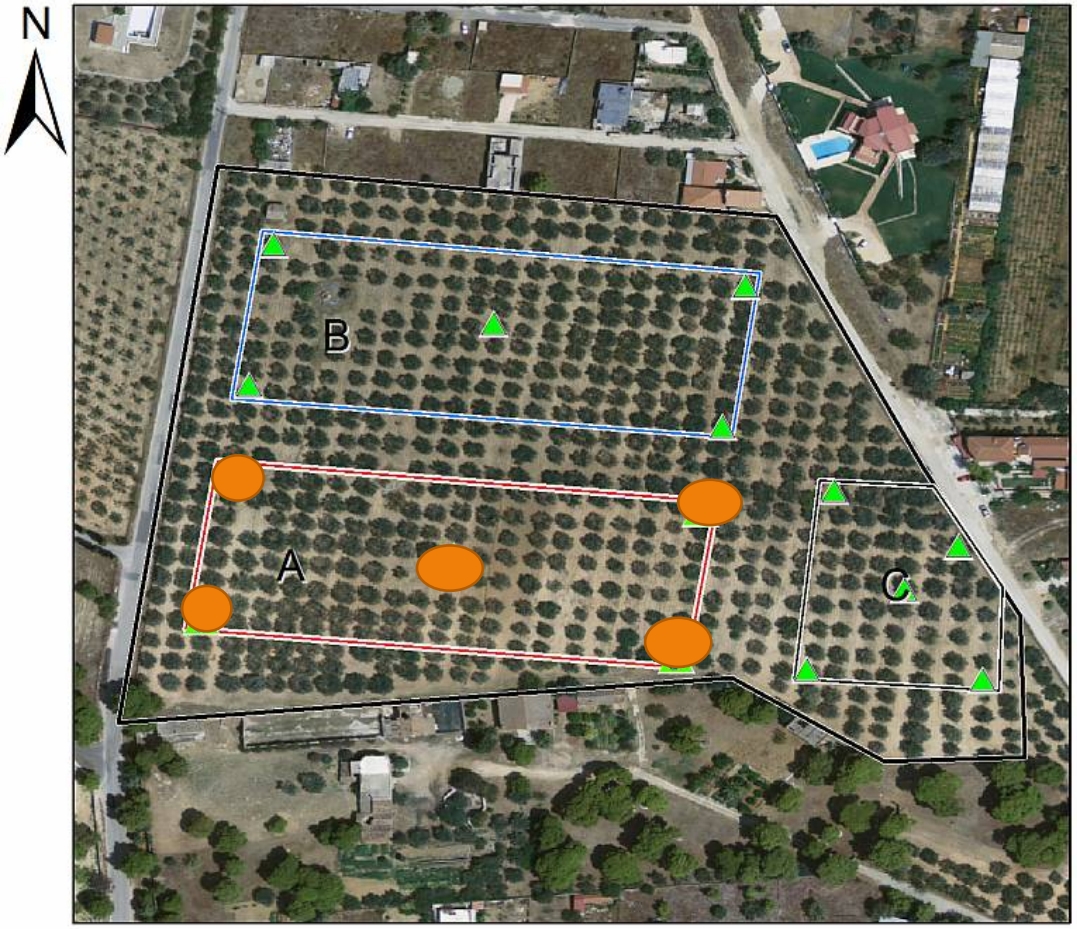
3. PEST MONITORING



Points to consider:

- in LAS plots: e-traps
- In NoLAS plots: standard methodology used by the farmer

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4. METEOROLOGICAL DATA MONITORING

Sensors (T: Temperature, RH: Relative humidity, W:Wind speed, P: Precipitation,

- DATA required for decision + spraying application
- Network of sensors for Temp, RH, Prec., Wind

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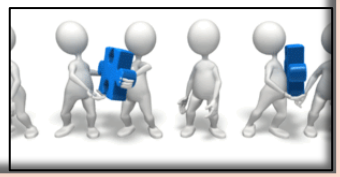
DSS stages for Olive Fly



A.
DSS trapping data collection

B.
DSS when to spray

C.
DSS where to spray -risk

D.
DSS how to spray

E.
DSS spraying action

A1. Automatic insect counting

A2.
Semi-automatic countring

A3. Using the mobile GIS

A4.
Manually

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Pest monitoring: The e-trap

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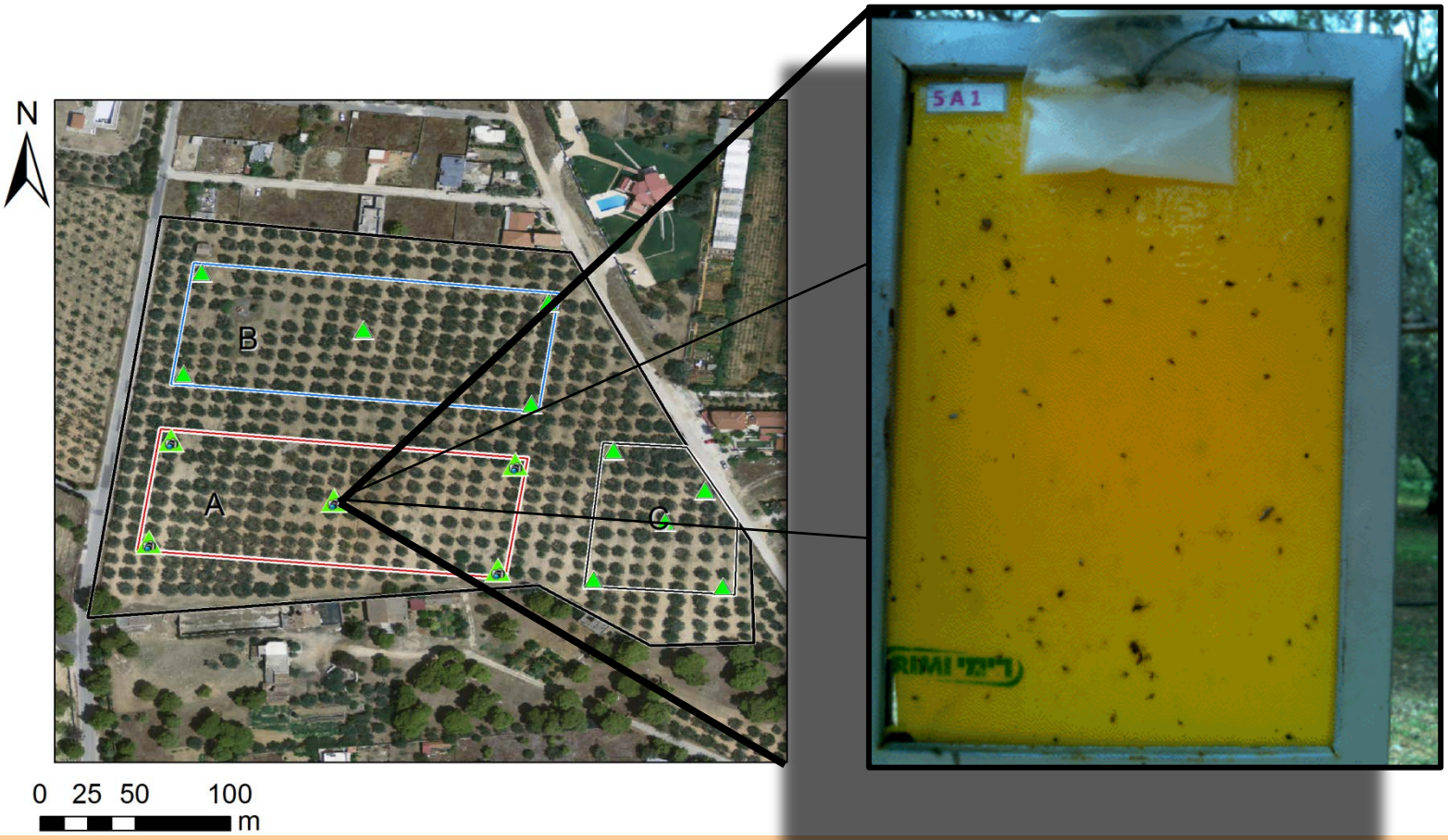
Pest monitoring: The e-trap



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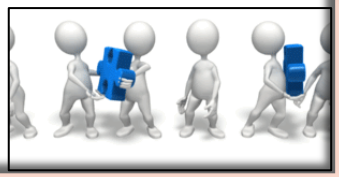
DSS stages for Olive Fly



A.
DSS trapping data collection

B.
DSS when to spray

C.
DSS where to spray

D.
DSS how to spray

E.
DSS spraying action

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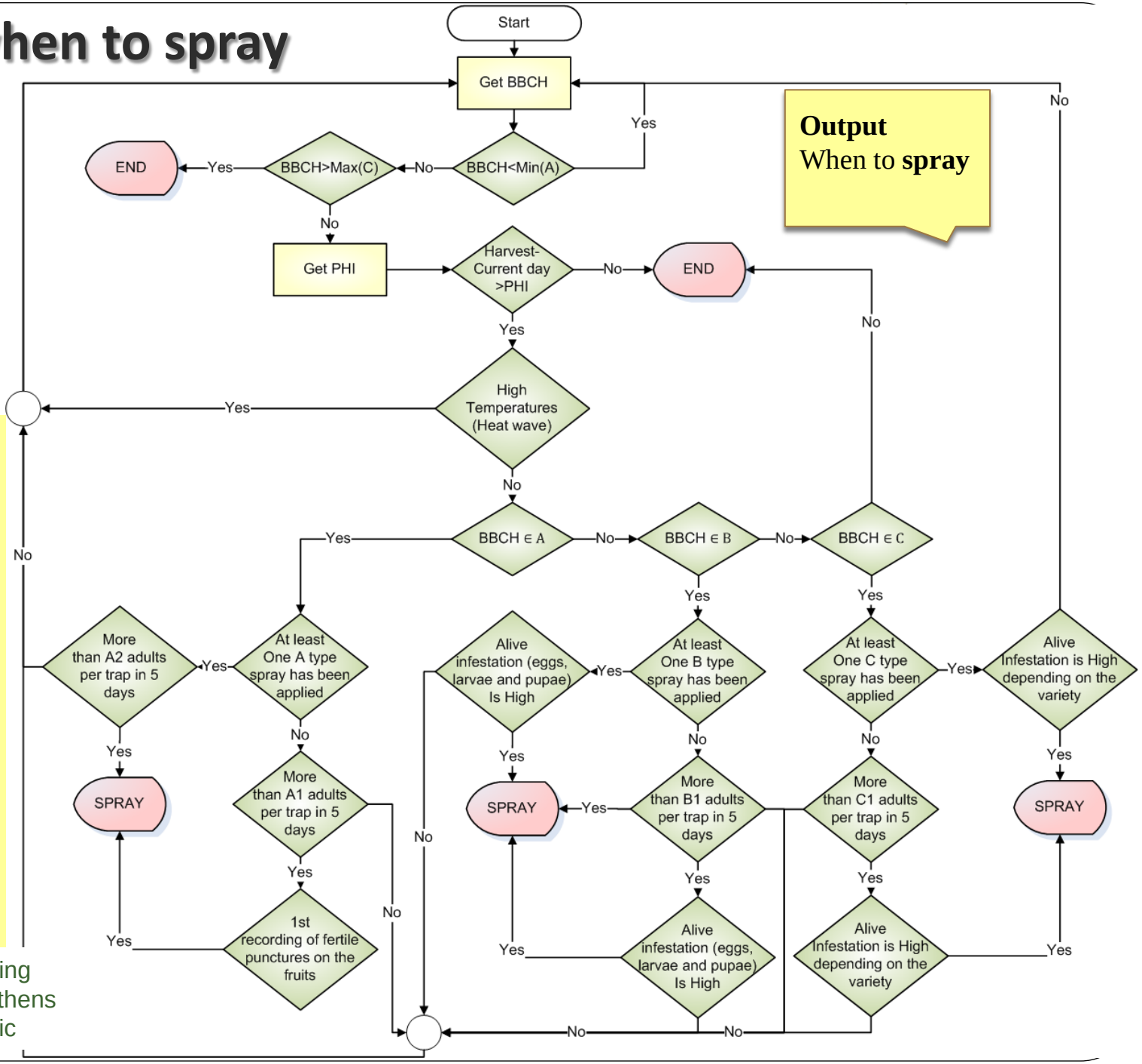
B. DSS when to spray (Alert)

BBCH RANGE	SPRAYING
A	1st
B	2nd
C	Others

Main Parameters
BBCH a scale used to identify the phenological development stages of the plant

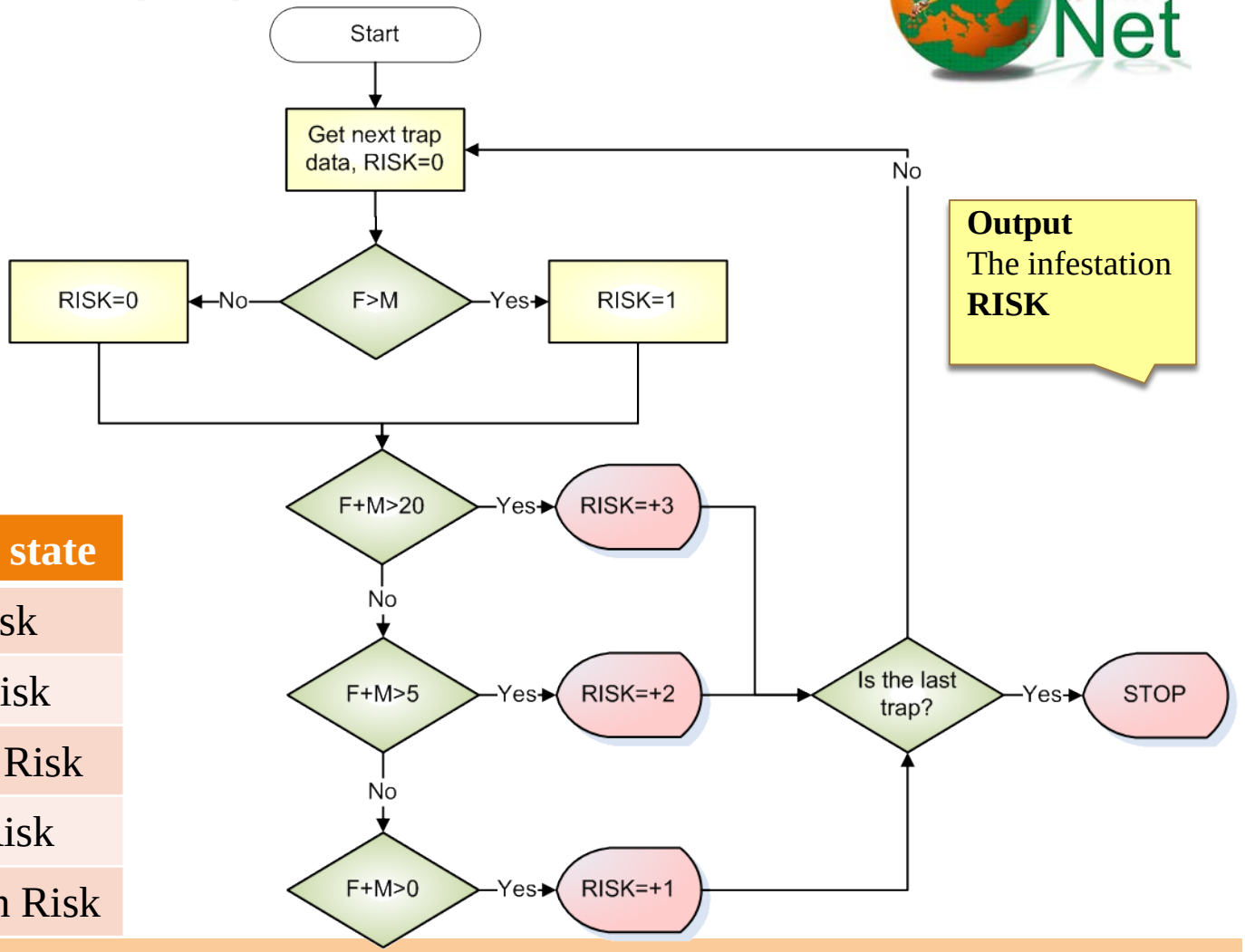
PHI (Pre-Harvest Interval)

Main Inputs
Temperature->WSN
Trap captures (adults) -> e-trapping, mTrapping
Alive Infestation->mGIS



C. DSS where to spray

Inputs
Trap captures
M: Males adults
F: female adults
-> e-trapping, mTrapping



Output
The infestation
RISK

Risk value	symbolic state
0	No Risk
1	Low Risk
2	Average Risk
3	High Risk
4	Very High Risk

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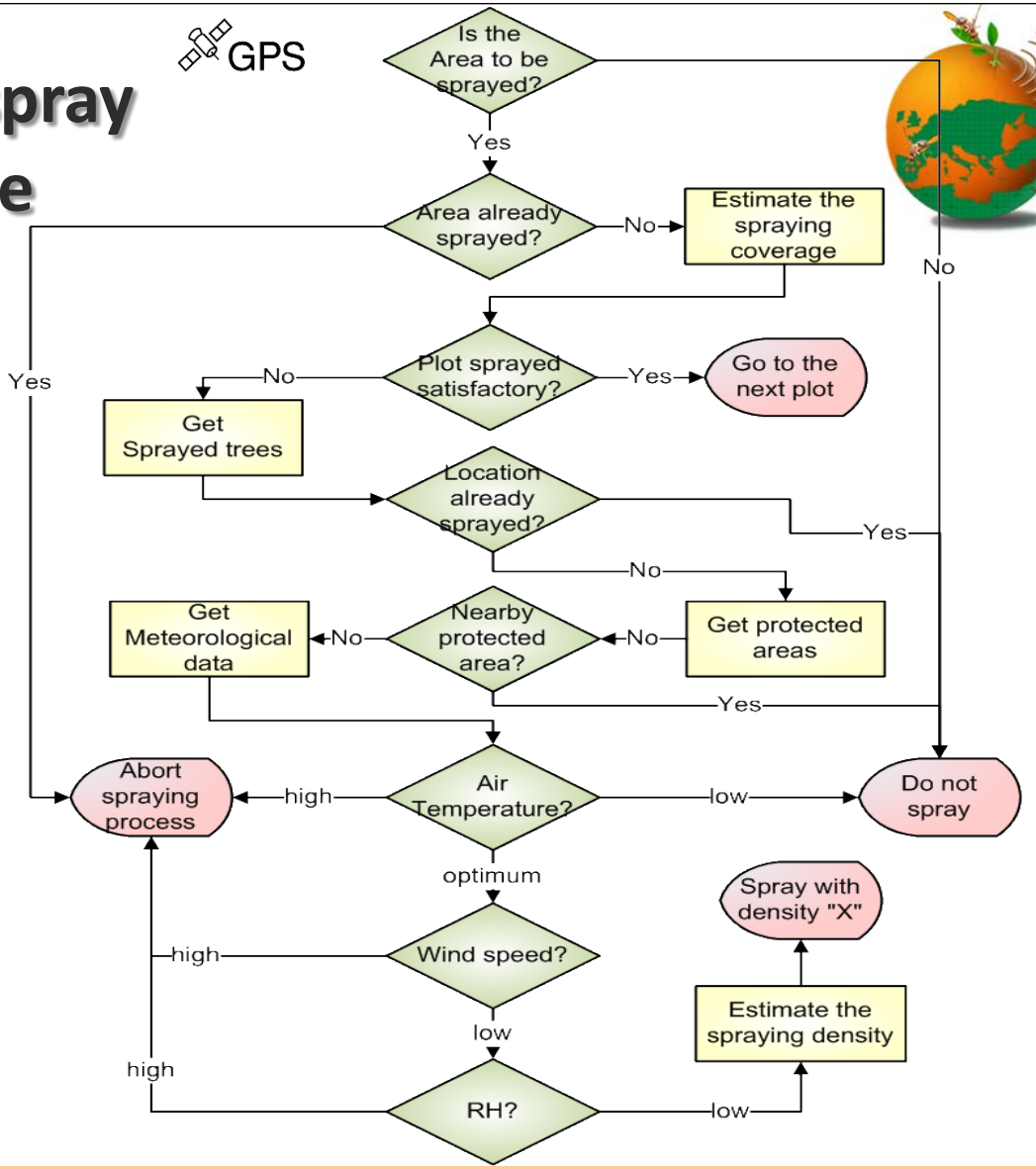
D. DSS how to spray Inference Engine

Input
Trees
Spray
Sensors
Traps
Polygons

Output
Go to the next plot
Abort spraying
Do not spray
Spray with specific density



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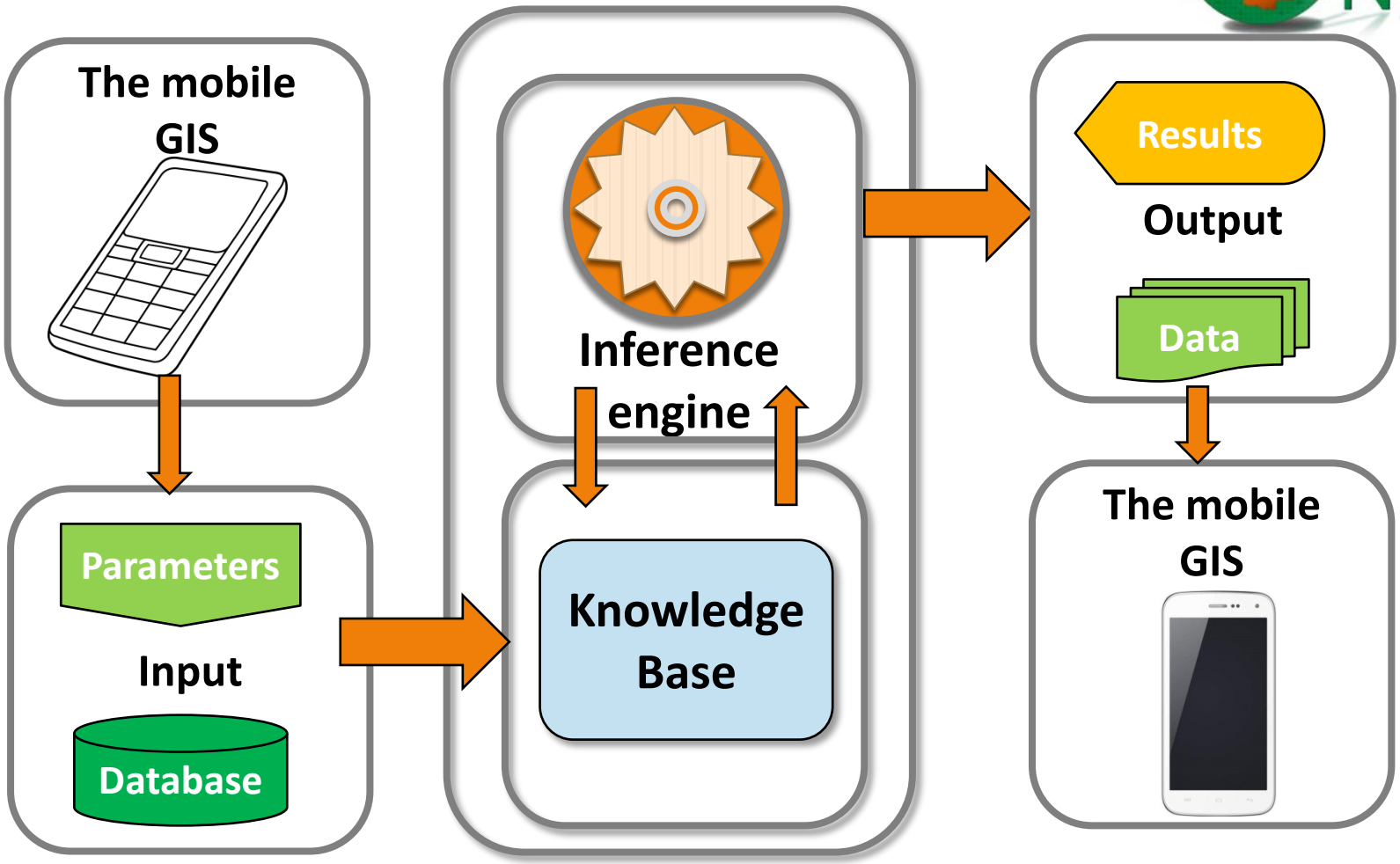
DSS components



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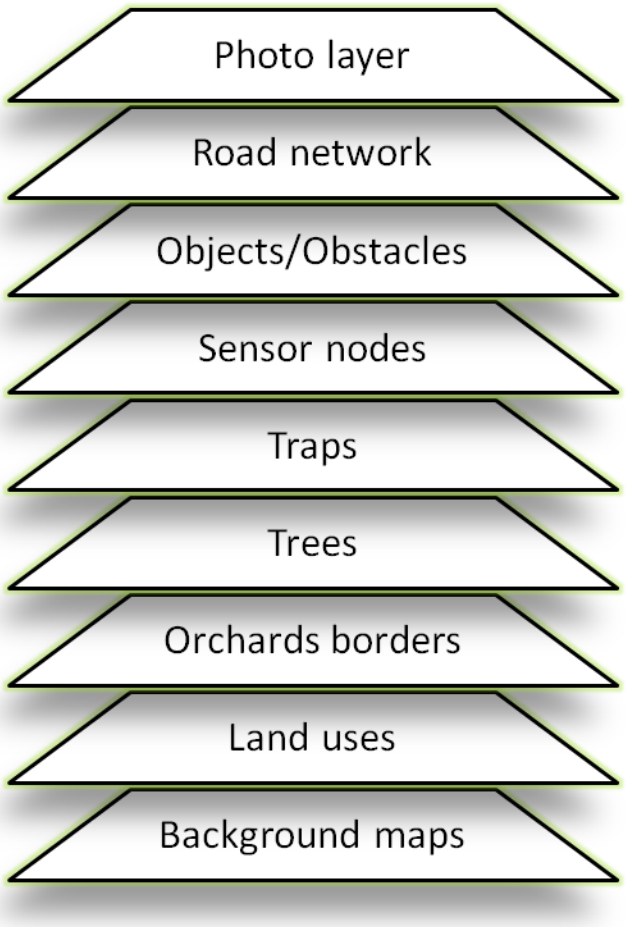
DIGITIZATION for location awareness



Points to consider:

- **Items to be digitized:**
  - **traps position**
  - **sensors position**
  - **varieties distribution**
  - **fruit load**
  - **tree location**
  - **obstacles/protected areas**
  - **….**

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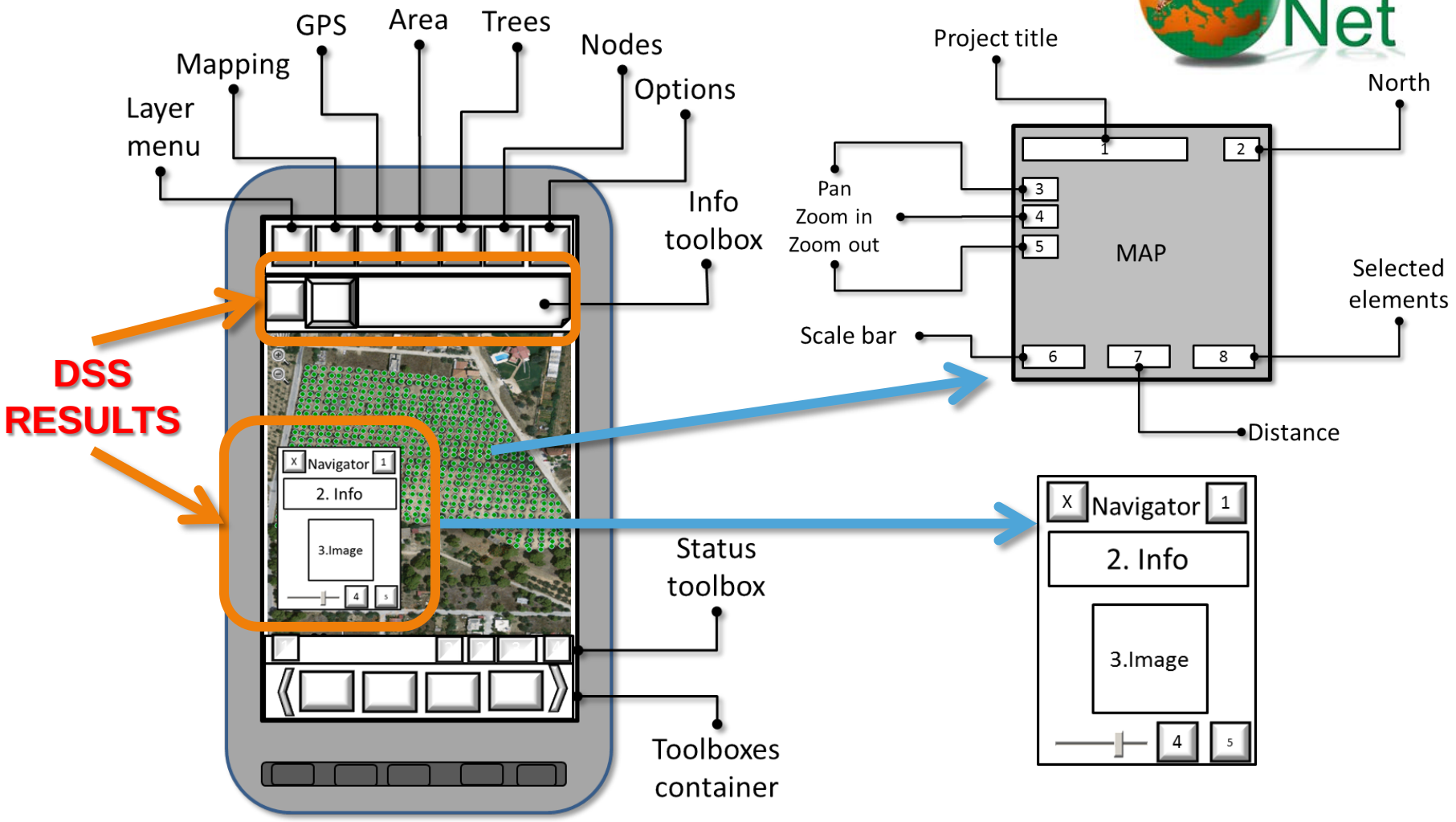
The Mobile GIS



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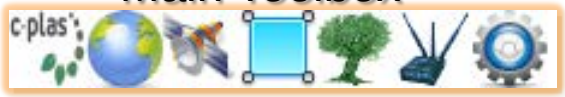
Mobile GIS-Toolboxes container

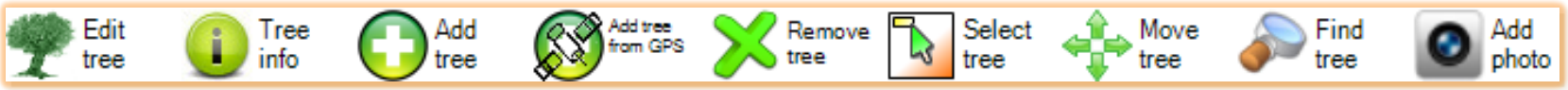
Main Toolbox



Mapping Toolbox

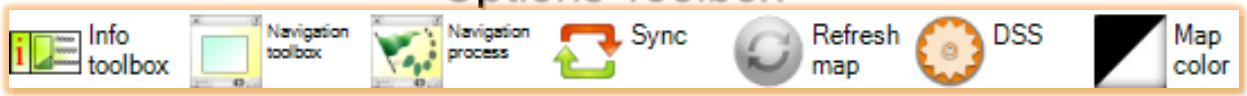
Areas Toolbox

Trees Toolbox



Nodes Toolbox

Options Toolbox



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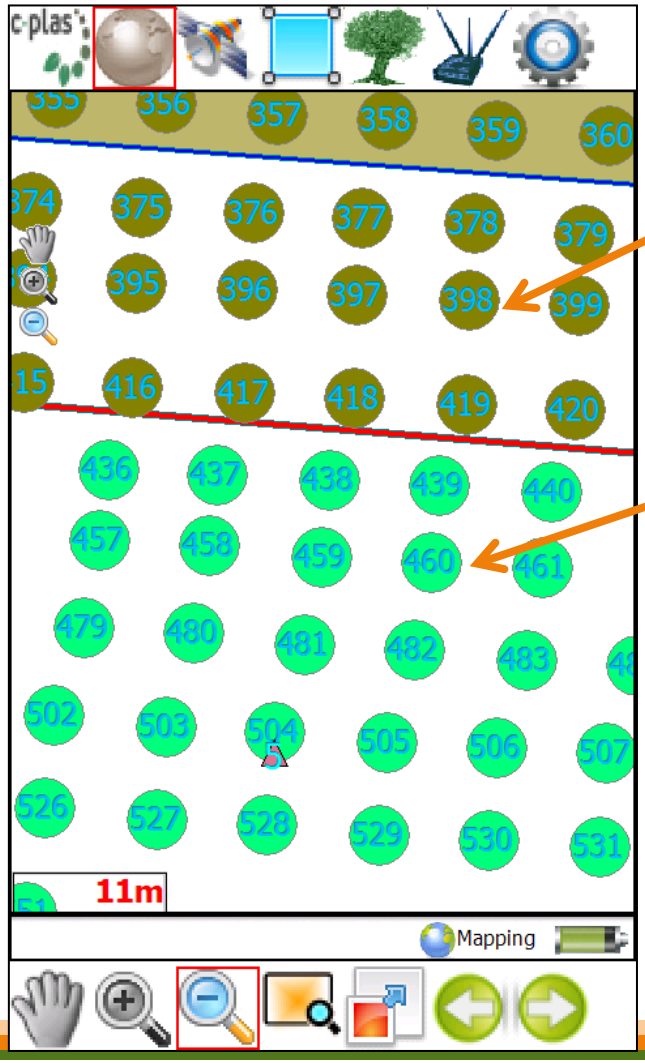
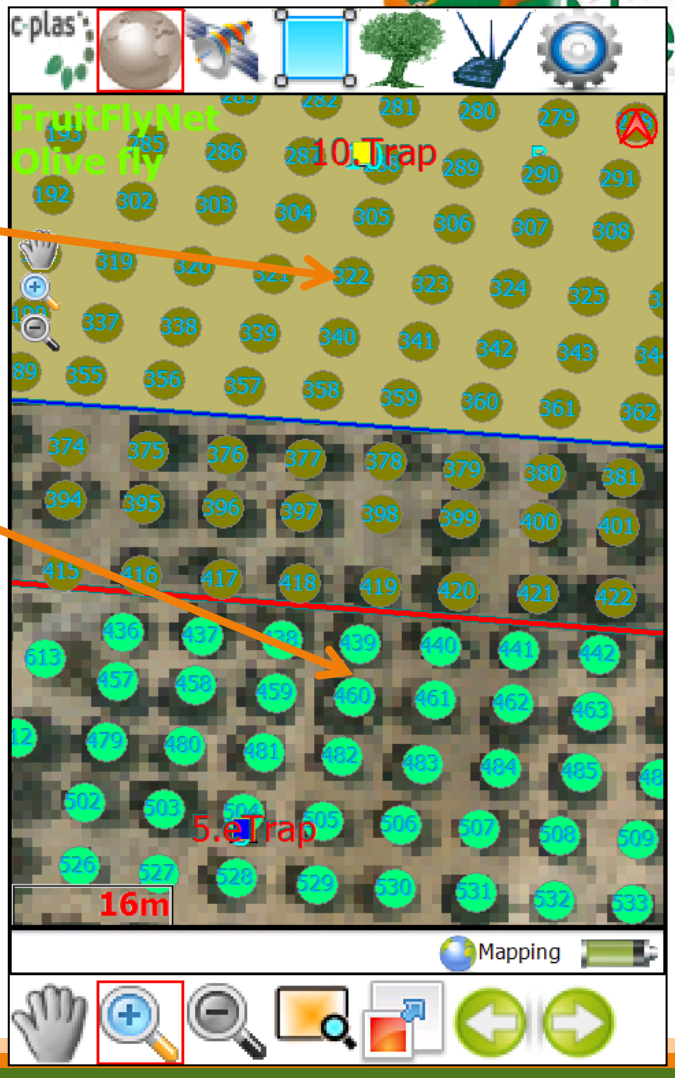
The layer of the trees



No LAS trees

LAS trees



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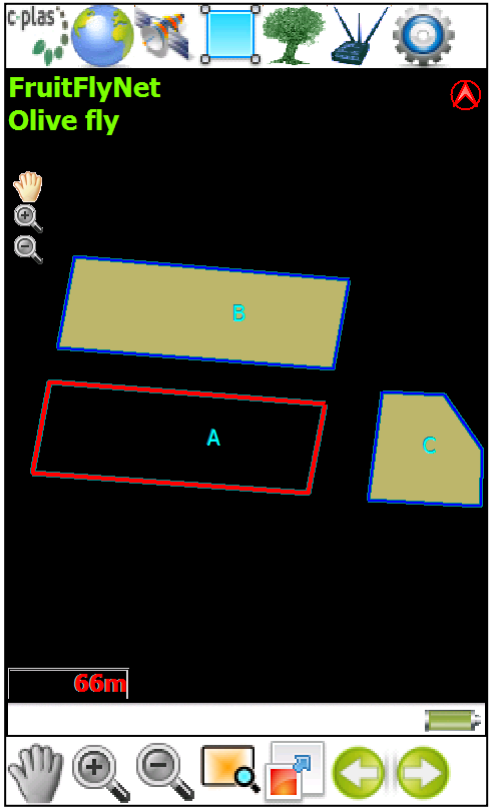
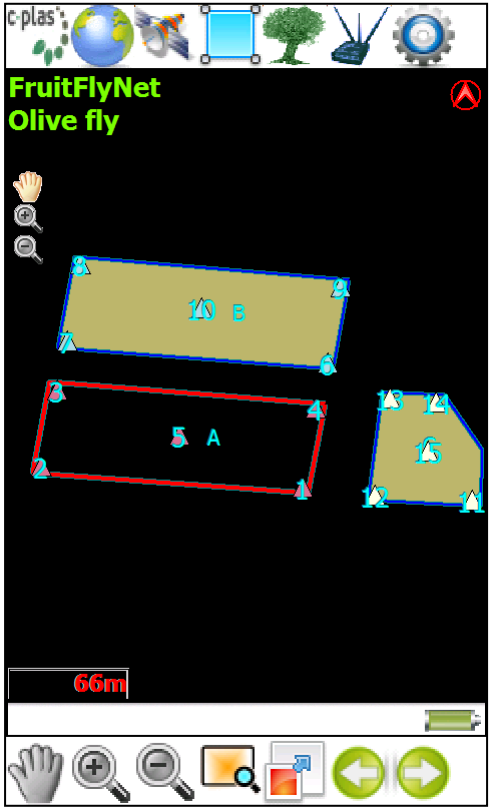
Other layers:

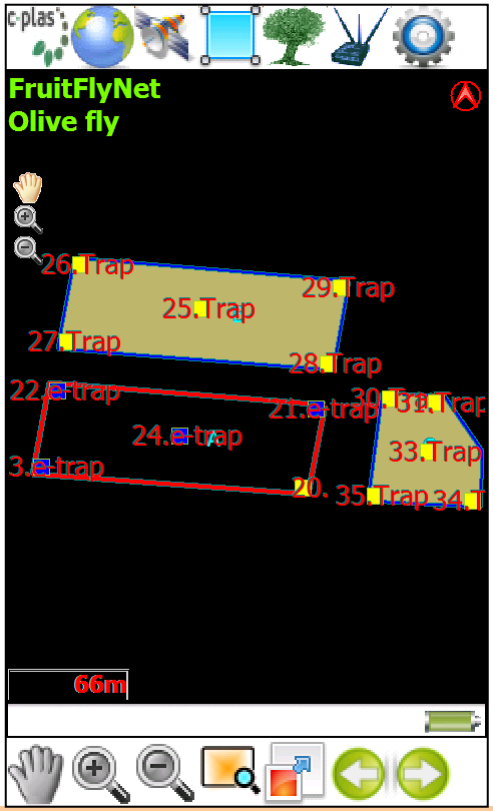
AREAS



+ SENSORS



+ TRAPS



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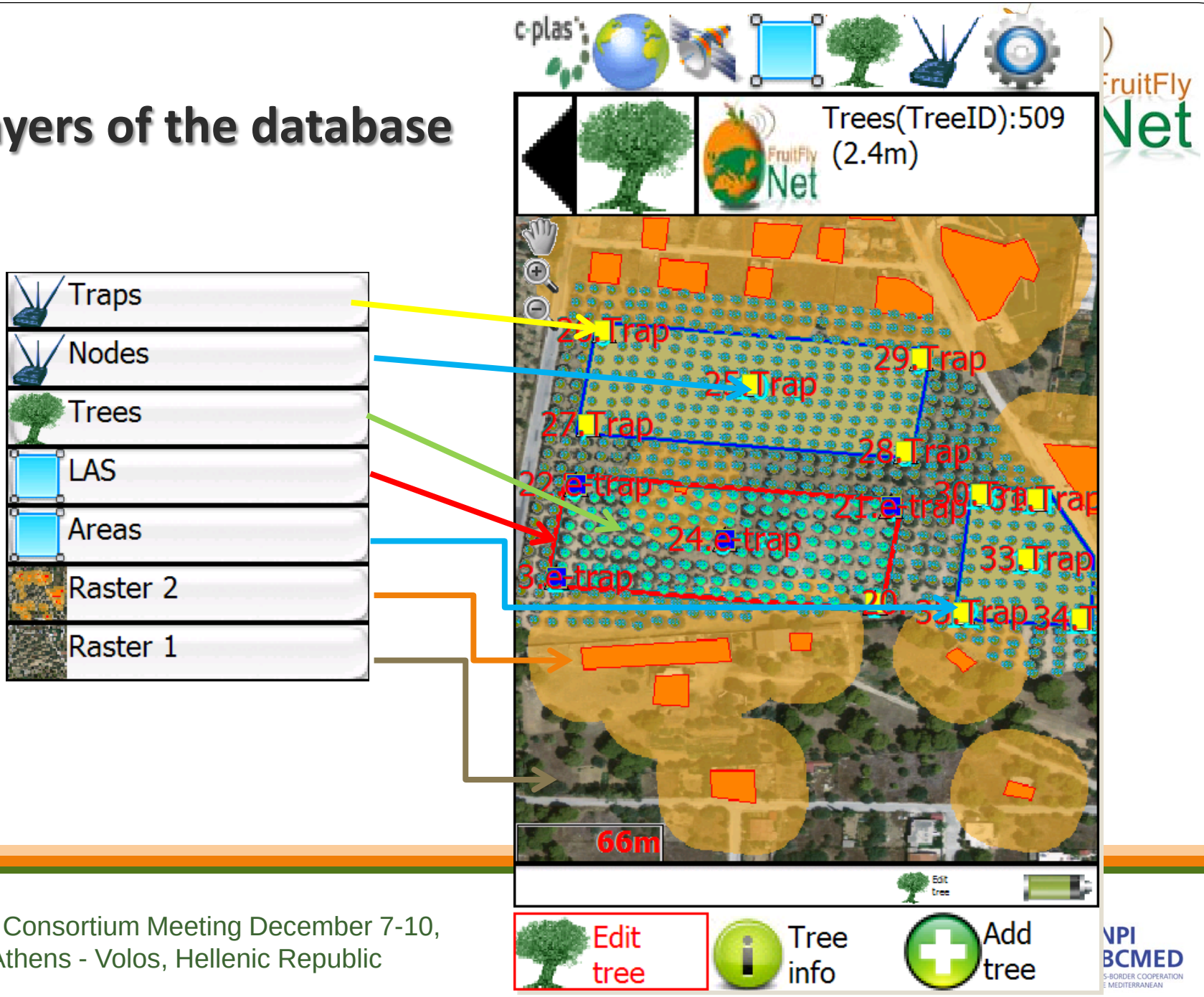
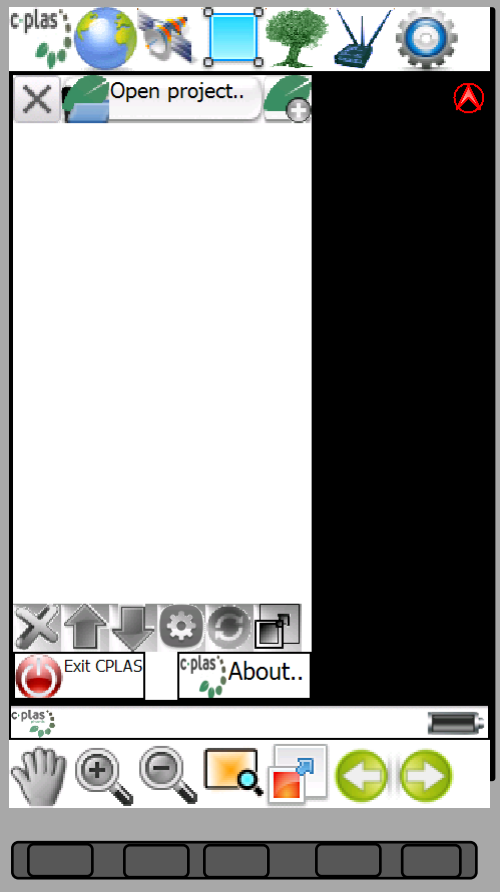
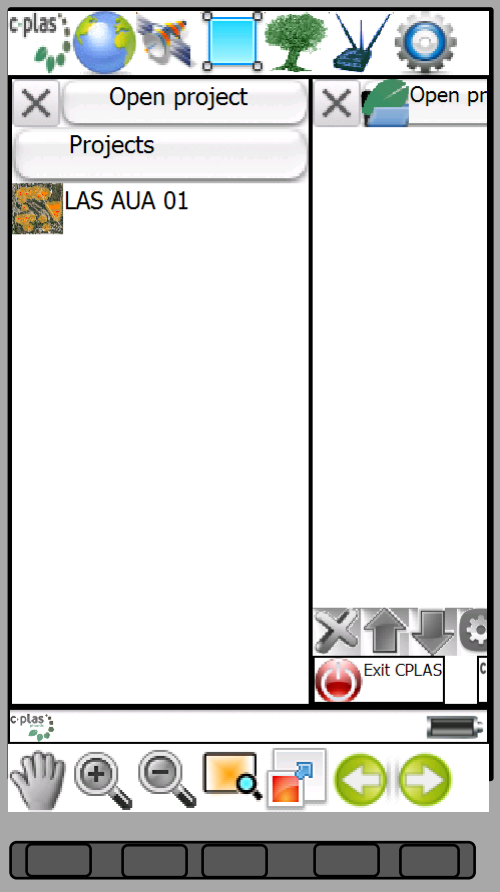
Layers of the database



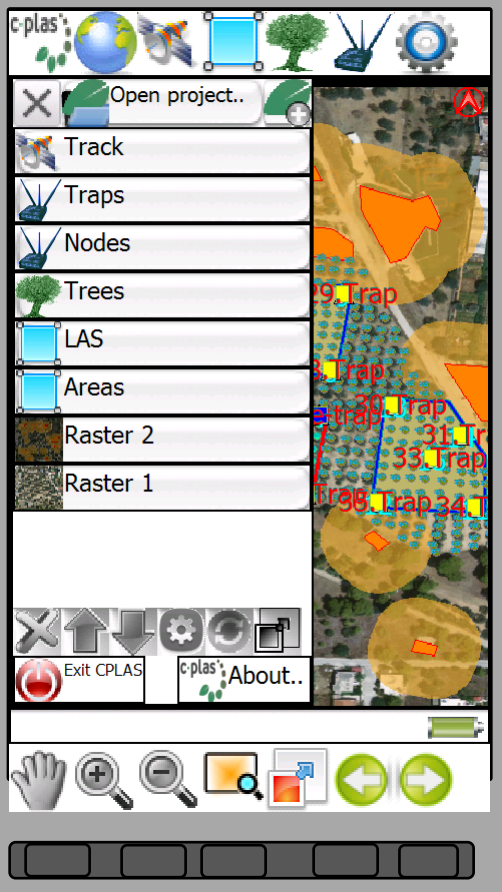
Mobile GIS-Project and Layers Toolbox (AUA)

Project Toolbox





Layers Toolbox



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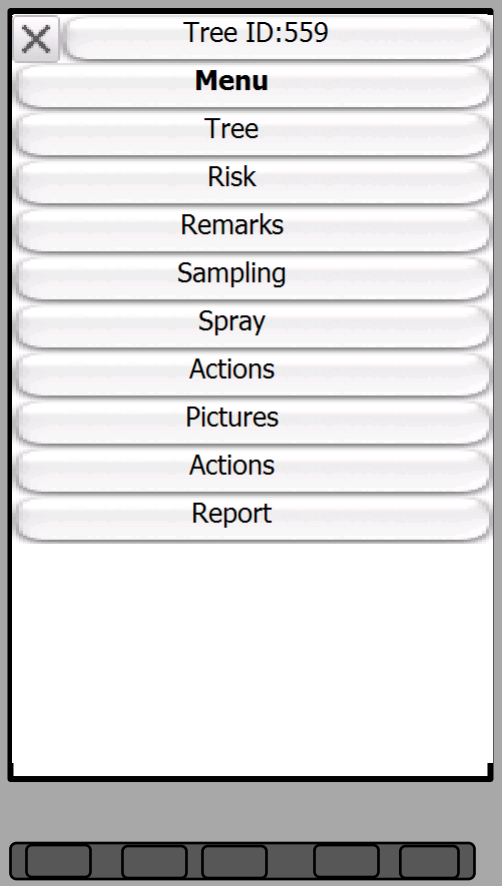
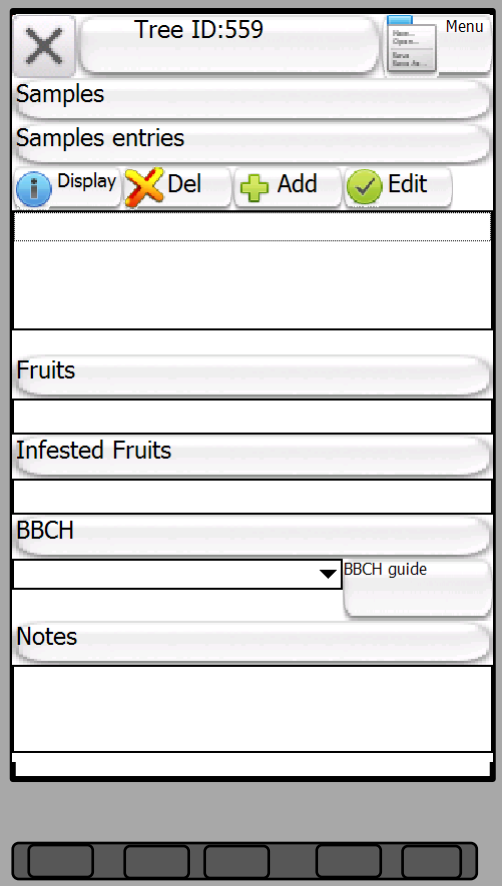
Mobile GIS-Data entry toolboxes

Locate tree

Open data entry menu



Open i.e. Sampling data entry form



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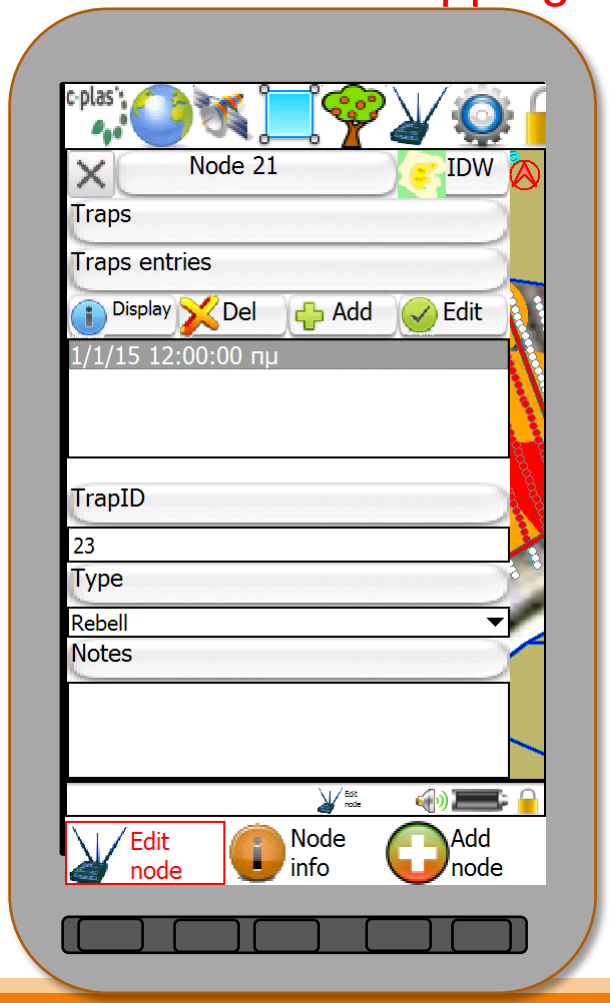
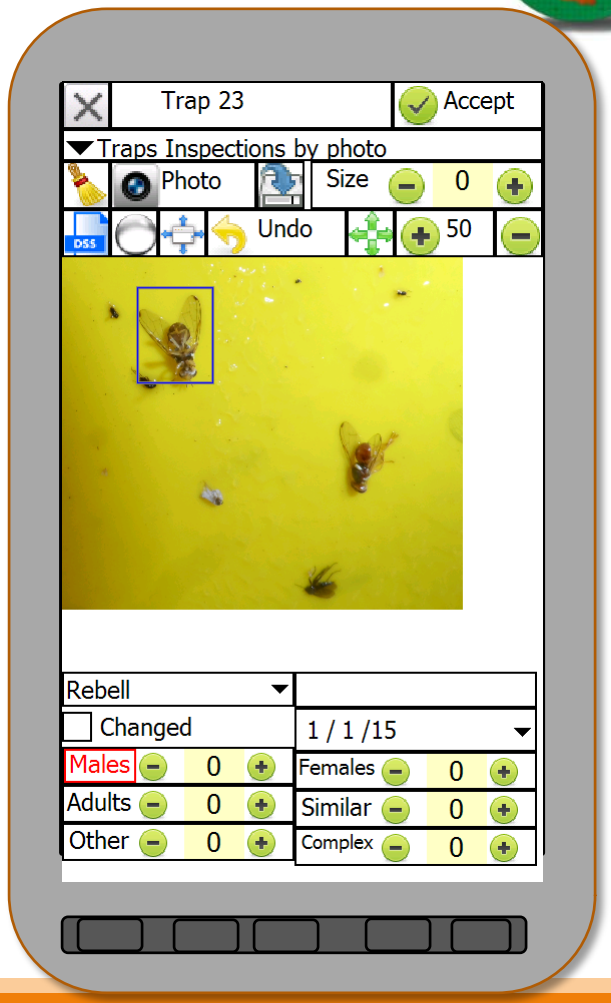
Mobile GIS-Trapping toolboxes

Trapping entry forms





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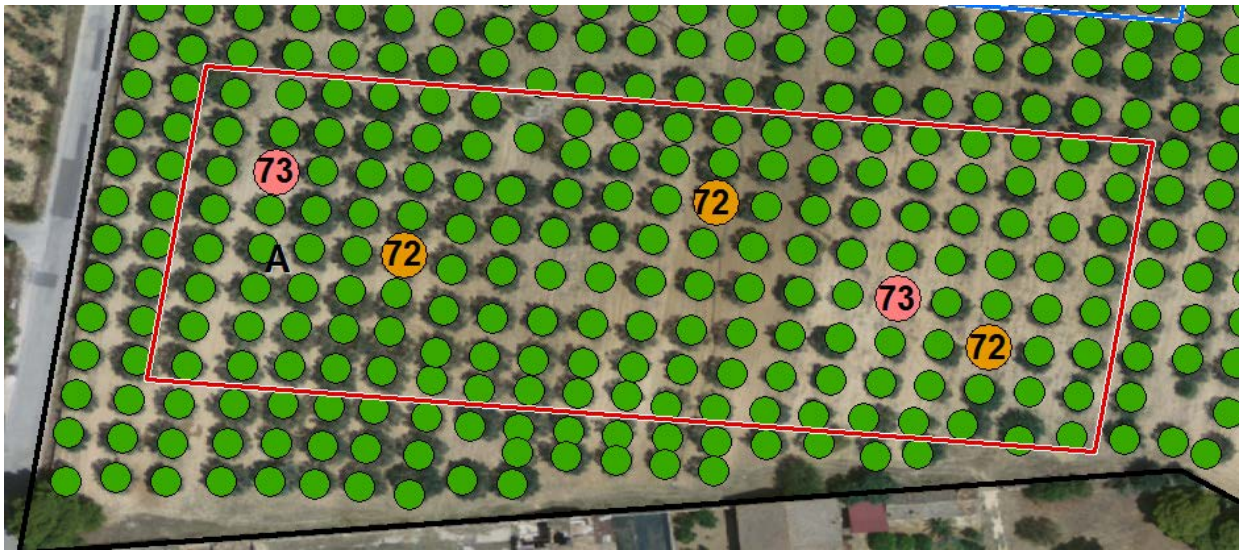
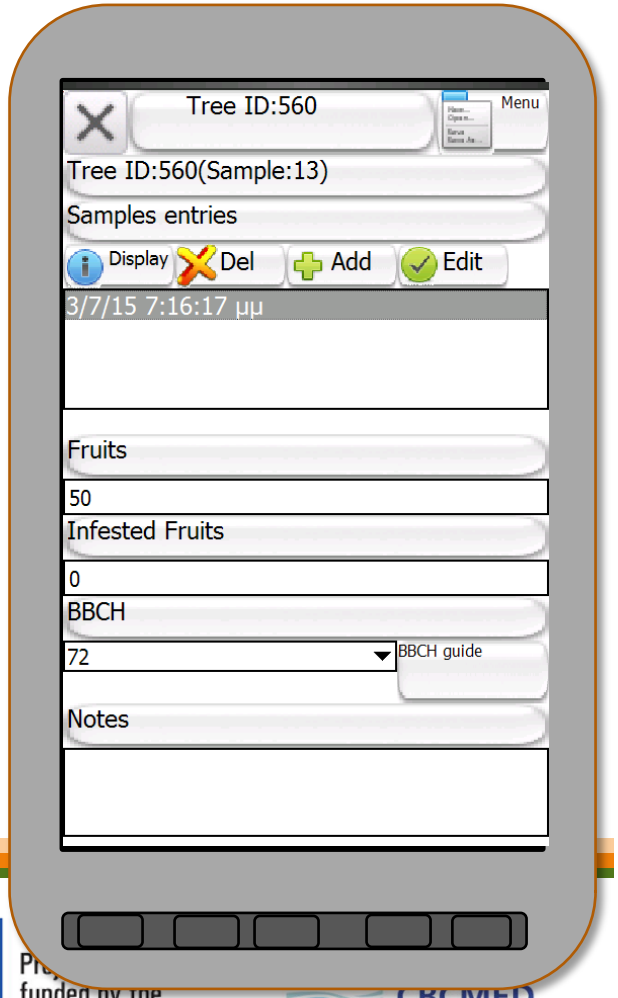
Fruit sampling for BBCH or pest damage

LAS



Mobile GIS



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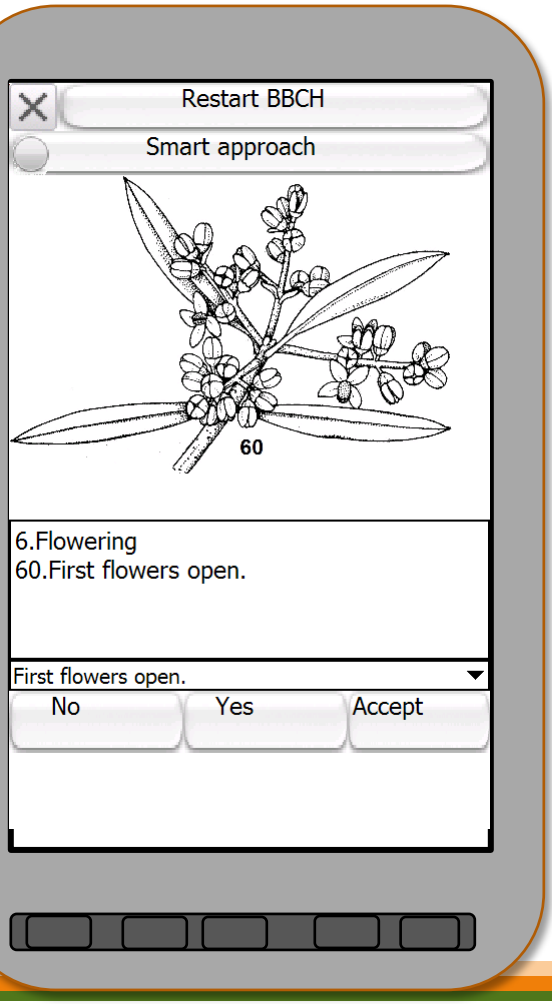
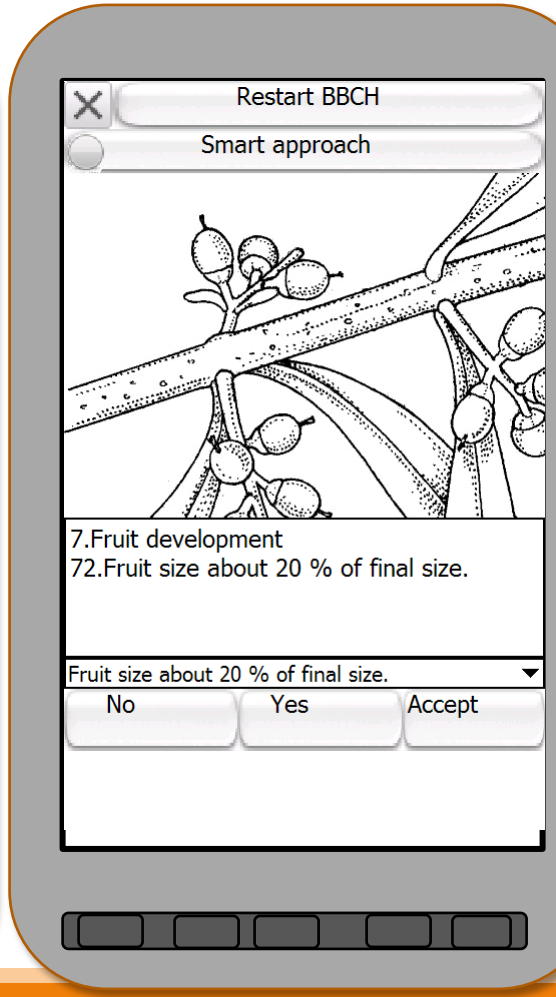
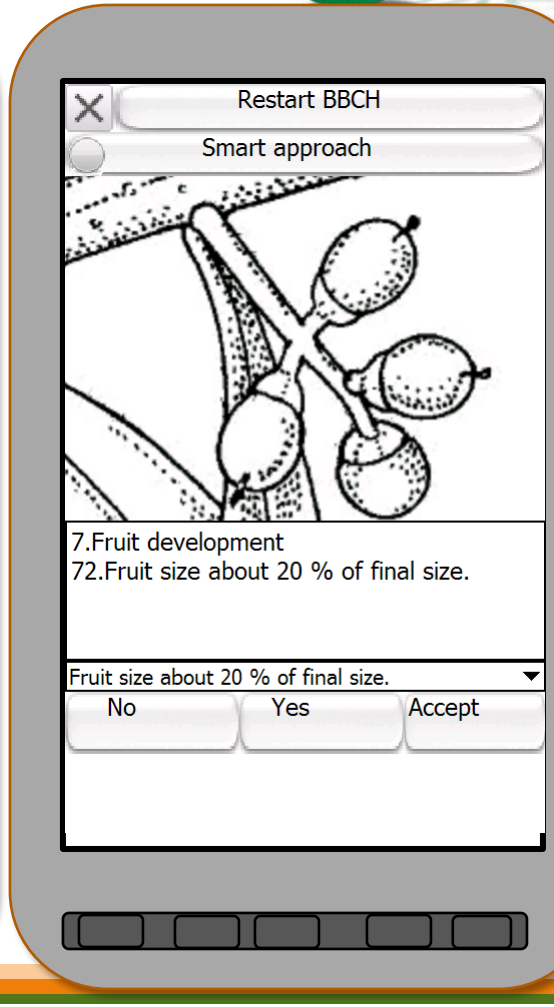
Mobile GIS-BBCH entry guide







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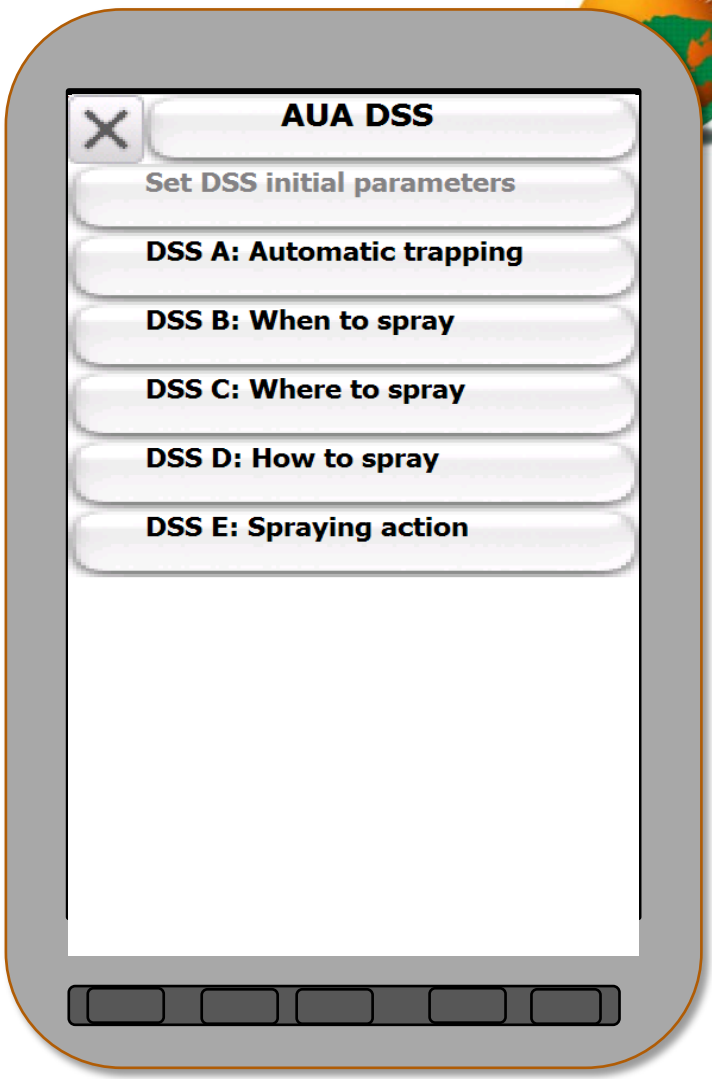
Mobile GIS - OUTPUTS:

DSS RUNNING ON THE PARAMETERS ENTERED TO SHOW: WHEN, WHERE, HOW TO SPRAY AND GUIDE/RECORD SPRAYING ACTION



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C. DSS – Where to spray/risk maps

Server

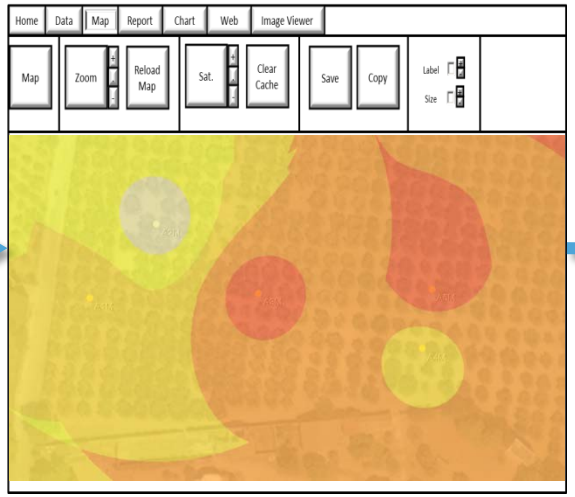
Store and Retrieve traps data

TRAPS

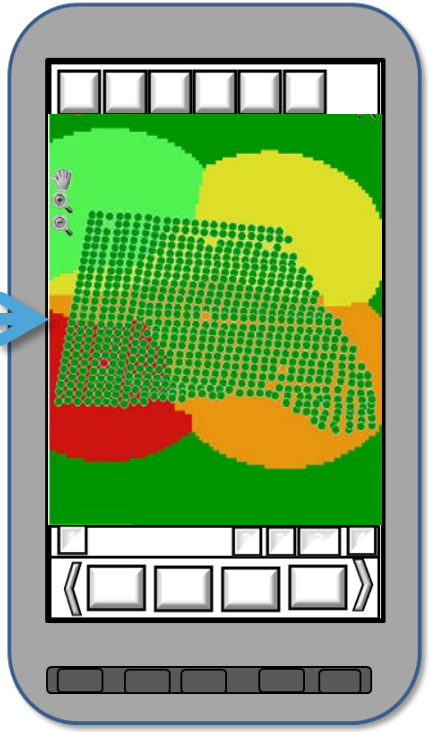
Web services

DSS

Analysis and creation of IDW maps



Mobile GIS



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PROTECTED AREAS

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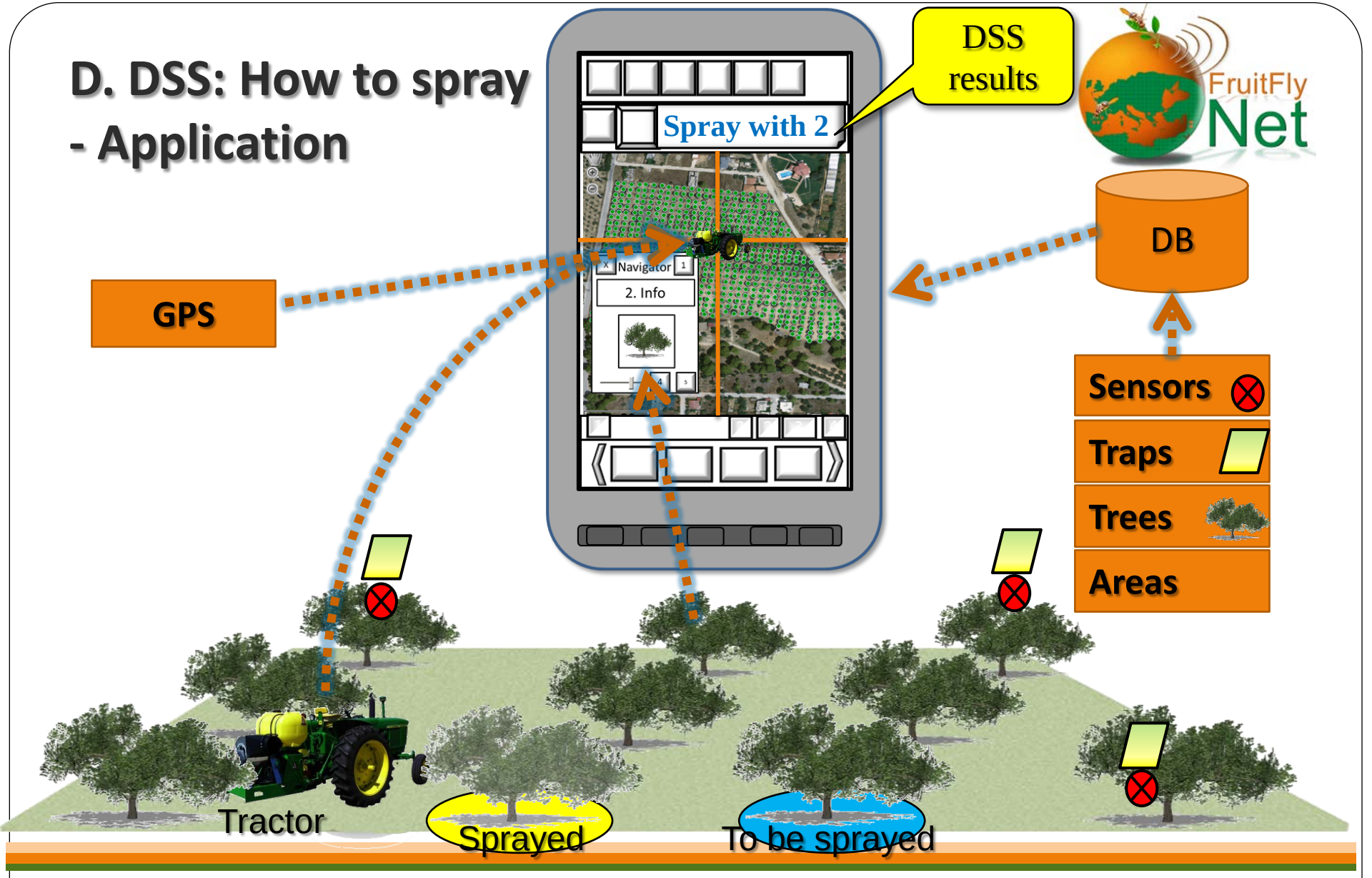
D. DSS: How to spray - Application



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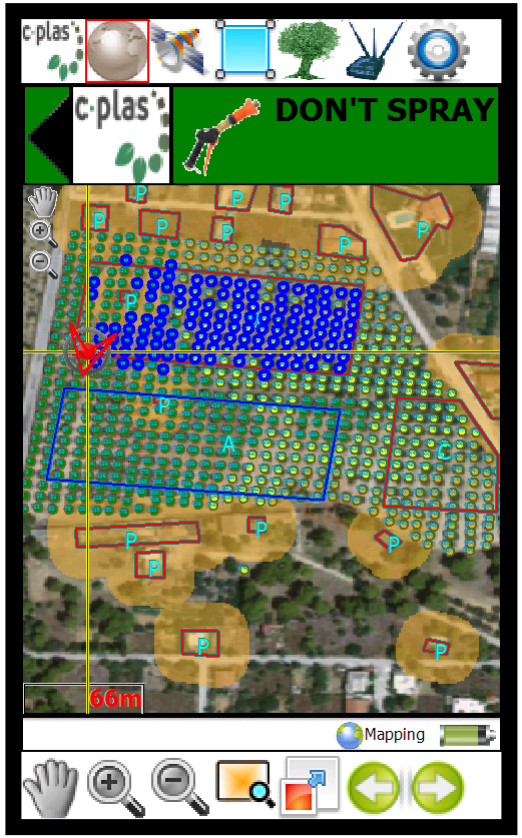
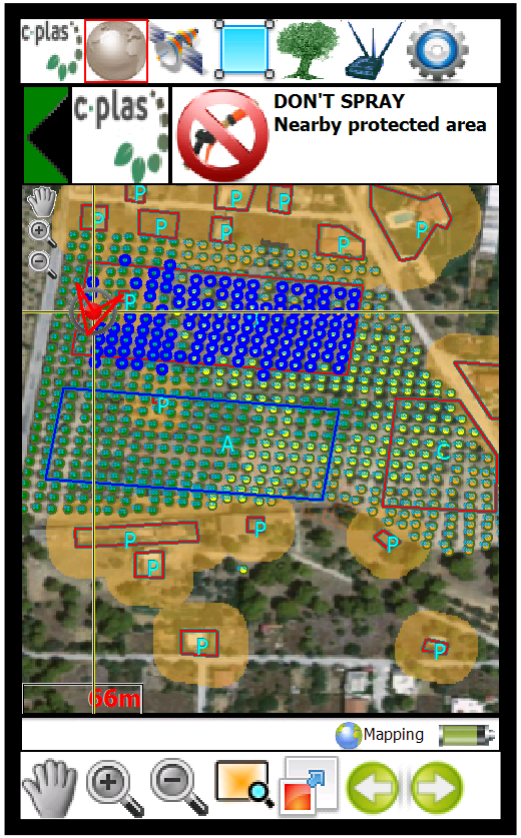
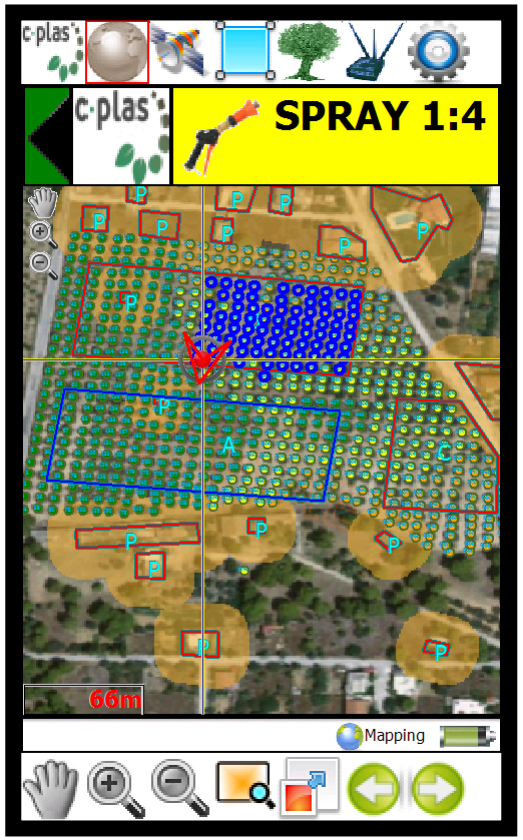
DSS D: How to spray







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6. SPRAYING DECISION

1.	Capture threshold	*A critical number is 2-5 flies per trap in 5 days for the first spraying in July, later it can be more than 5.*
2.	Damage threshold on the fruits during the season	*For the first spraying it is the first recording of fertile punctures on the fruits, for the next sprayings is the alive infestation (eggs, larvae and pupae) 1-2 or 3-5% depending on the variety and generation.*
3.	Fruit color or other characteristic	*Hardening of fruit kernel important for first spraying in July - BBCH*
4.	Critical climatic conditions	*Temperature (lower than 14ºC, 33ºC or higher)*
5.	Risk scale description and respective measures (i.e. ratio of trees to be sprayed for bait sprayings)	*This will be related to the captures, the damage level and the meteorological conditions.*

Points to consider:

- Trapping and sampling data
- Scale of risk in LAS

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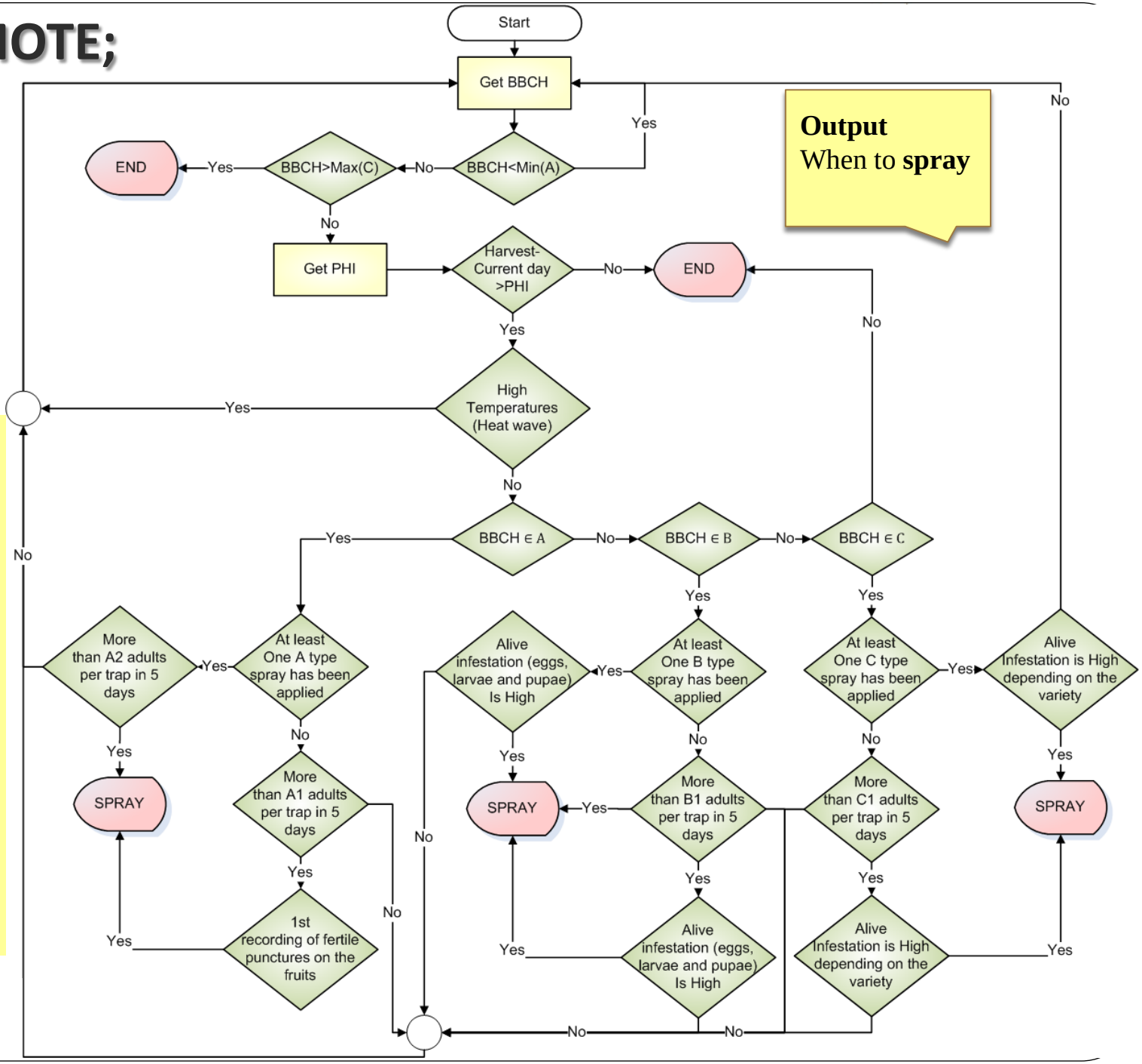
B. DSS: ΠΟΤΕ;

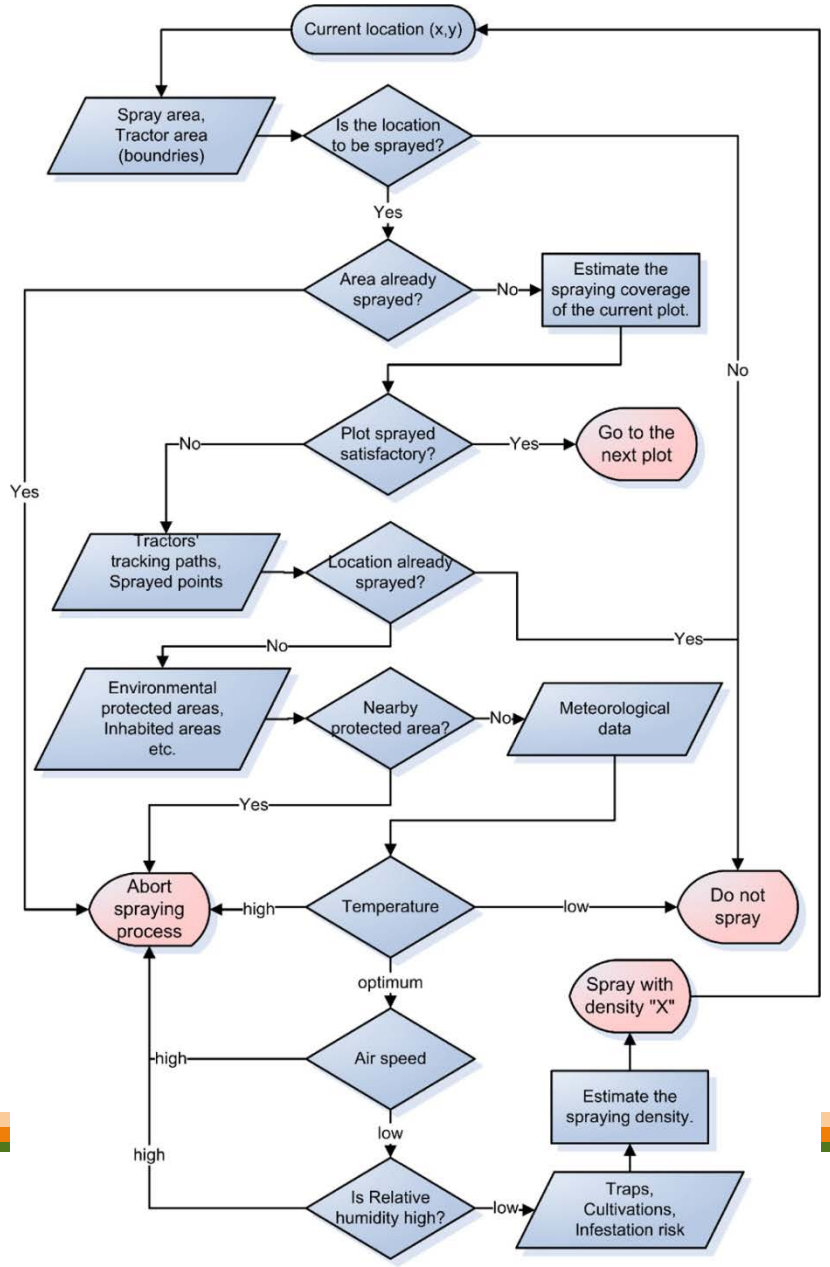
BBCH RANGE	SPRAYING
A	1st
B	2nd
C	Others

Main Parameters
BBCH a scale used to identify the phenological development stages of the plant

PHI (Pre-Harvest Interval)

Main Inputs
Temperature->WSN
Trap captures (adults) -> e-trapping, mTrapping
Alive Infestation->mGIS





7. SPRAYING APPLICATION

- Type of spray: bait
- Weather conditions
- Adjust tractor tracking and areas to be sprayed according to: interpolation of pest risk, variety, fruit load, obstacles.

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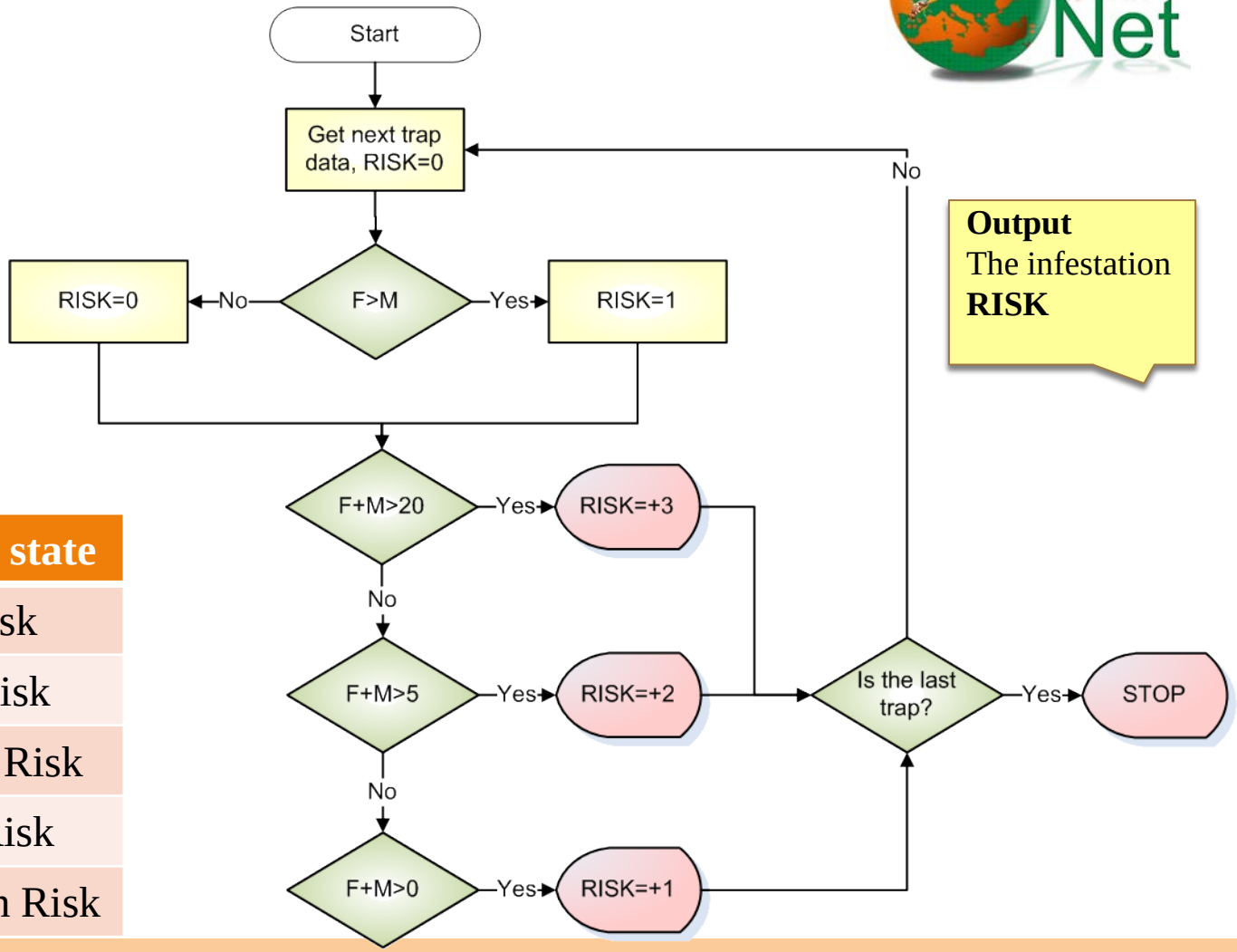
meters of the DSS B are shown in the following table.

#	Parameter (Type)	Value/Threshold	Notes
1	BBCH_A1 (Integer)	75	The lower limit of the A BBCH range
2	BBCH_A2 (Integer)	78	The upper limit of the A BBCH limit
3	BBCH_B1 (Integer)	78	The lower limit of the B BBCH range
4	BBCH_B2 (Integer)	80	The upper limit of the B BBCH limit
5	BBCH_C1 (Integer)	80	The lower limit of the C BBCH range
6	BBCH_C2 (Integer)	85	The upper limit of the C BBCH limit
7	A (Range Integer)	[BBCH_A1 - BBCH_A2)	The range BBCH for the 1st spray
8	B (Range Integer)	[BBCH_B1 - BBCH_B2)	The range BBCH for the 2nd spray
9	C (Range Integer)	[BBCH_C1 - BBCH_C2)	The range BBCH for the other sprays
10	MeanAdultsPerTrapPer5DaysA or A1 (Double)	2	The mean adult insect per trap and per 5 days for the 1st spray
11	MeanAdultsPerTrapPer5DaysB or B1 (Double)	3	The mean adult insect per trap and per 5 days for the 2nd spray
12	MeanAdultsPerTrapPer5DaysC or C1 (Double)	5	The mean adult insect per trap and per 5 days for the other sprays
13	NoFertilePuncturesOnFruitsA (Integer)	1	The number of fertile punctures on fruits
14	PerCentAliveInfestationOnFruitsBmin (Double)	1	The lower threshold of the per cent alive infestation on fruits for the 2nd spray
15	PerCentAliveInfestationOnFruitsBmax (Double)	2	The upper threshold of the per cent alive infestation on fruits for the 2nd spray

C. DSS: ΠΟΥ;

Inputs
Trap captures
M: Males adults
F: female adults
-> e-trapping, mTrapping



Output
The infestation
RISK

Risk value	symbolic state
0	No Risk
1	Low Risk
2	Average Risk
3	High Risk
4	Very High Risk

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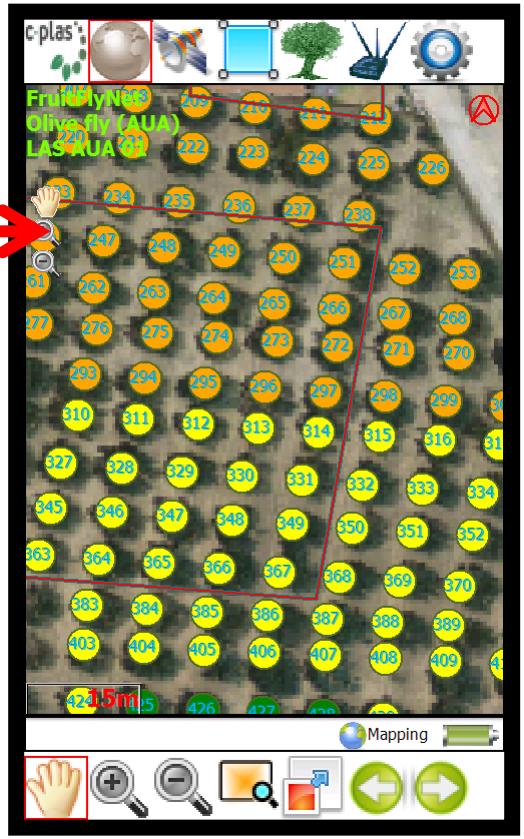
DSS C: Που θα γίνει ψεκασμός

Βαθμός επικινδυνότητας	Λεκτικό Επικινδυνότητας
0	Καθόλου
1	Χαμηλή
2	Μέτρια
3	Υψηλή
4	Πολύ υψηλή



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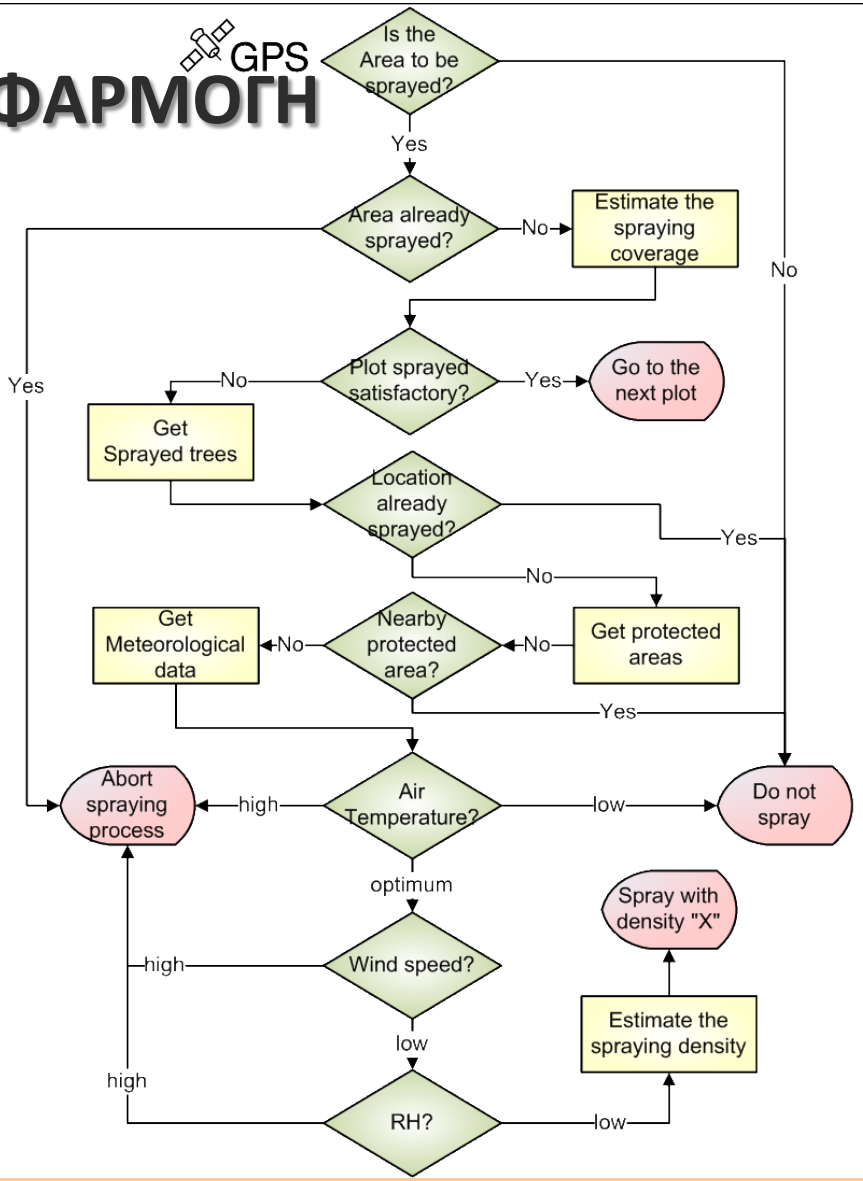
D. DSS: ΠΩΣ - ΕΦΑΡΜΟΓΗ

Input
Trees
Spray
Sensors
Traps
Polygons



Output
Go to the next plot
Abort spraying
Do not spray
Spray with specific density

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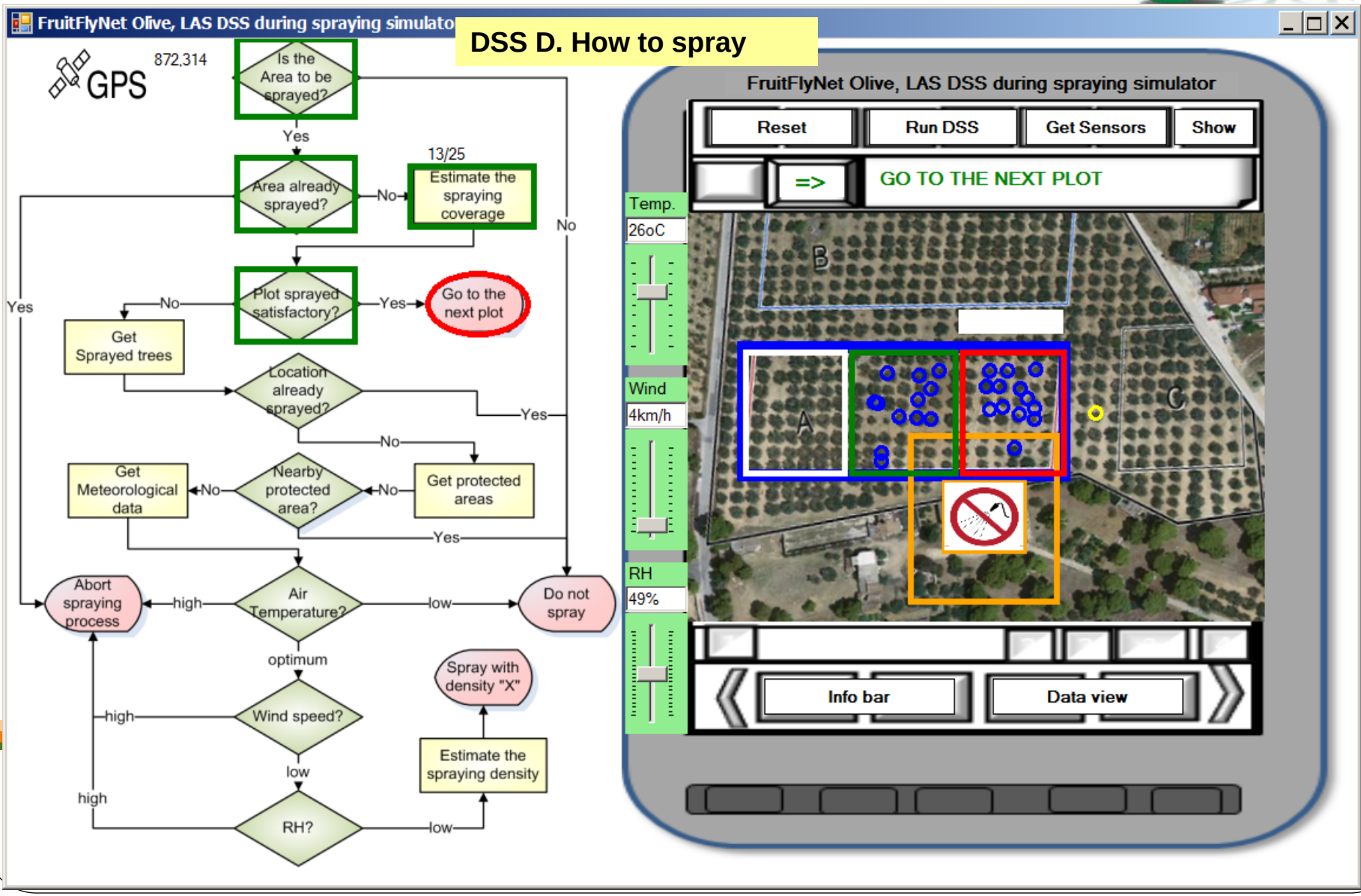
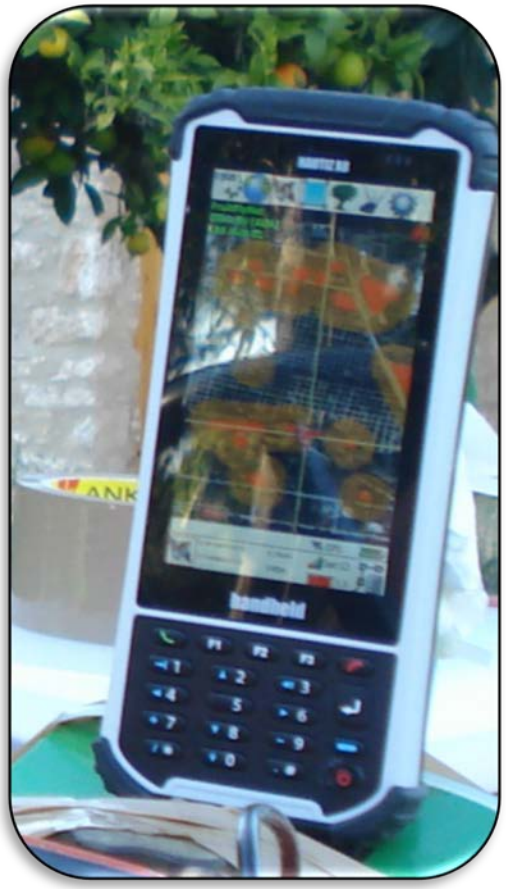
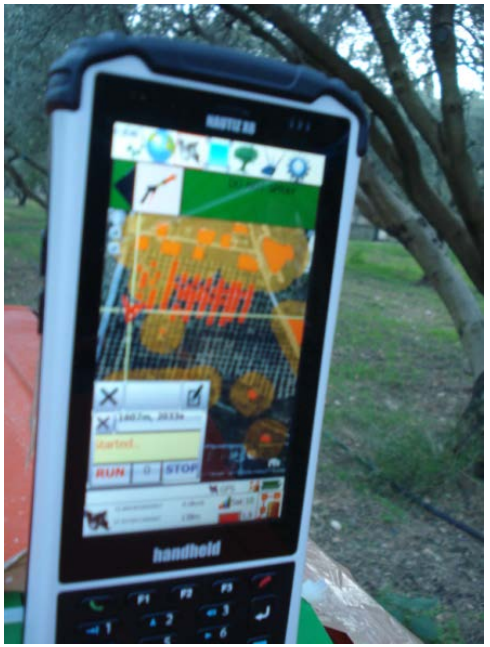
DSS D. How to spray



Ψεκασμός (Συμβατικό τεμάχιο-No LAS)

Καταγραφή





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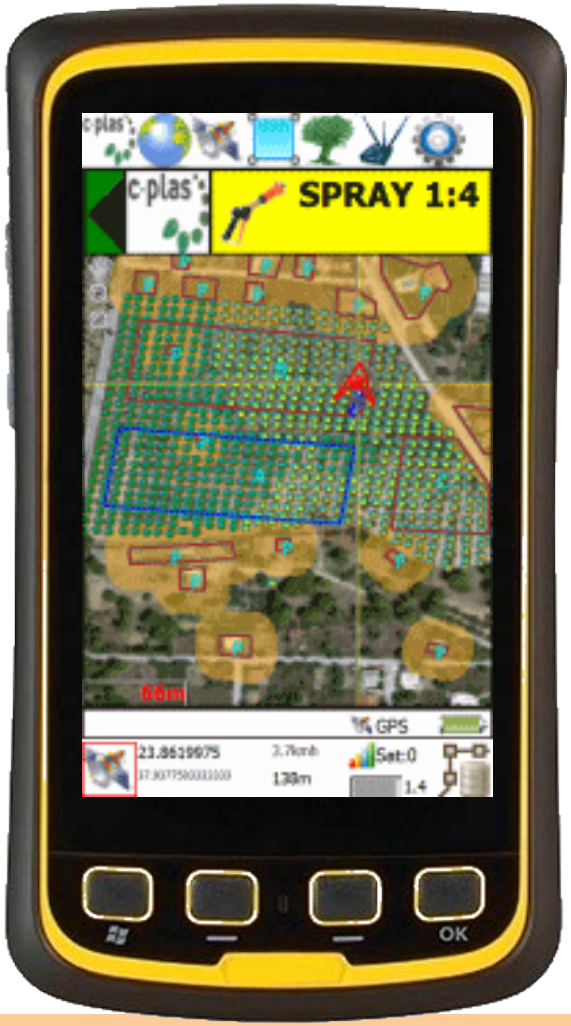
Ψεκασμός (Συμβατικό τεμάχιο - No LAS)

DSS D: Πως θα γίνει ο ψεκασμός



Πρώτα (προφανή) αποτελέσματα:

- **Σπατάλη ψεκαστικού (ψεκάστηκαν περισσότερα δέντρα)**
- **Ψεκασμός εκτός περιοχής ψεκασμού**

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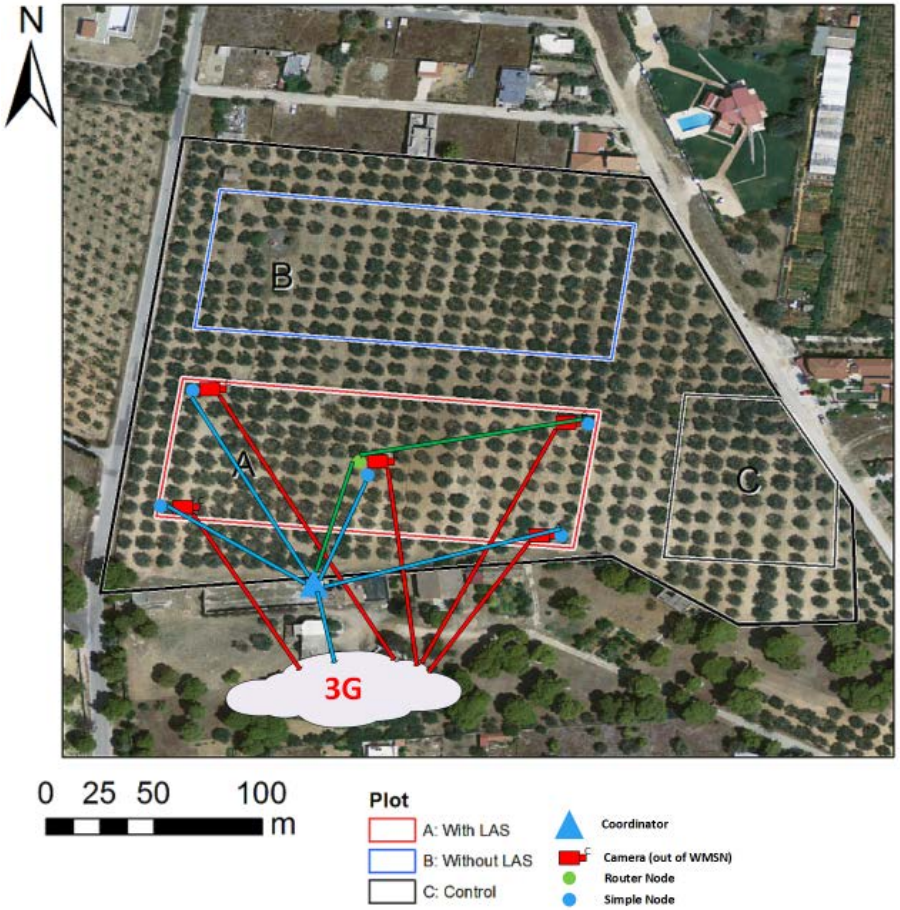
ΜΕΤΑΦΟΡΑ ΔΕΔΟΜΕΝΩΝ – ΔΙΚΤΥΟ΄Η ΜΕΜΟΝΩΜΕΝΗ ΑΠΟΣΤΟΛΗ



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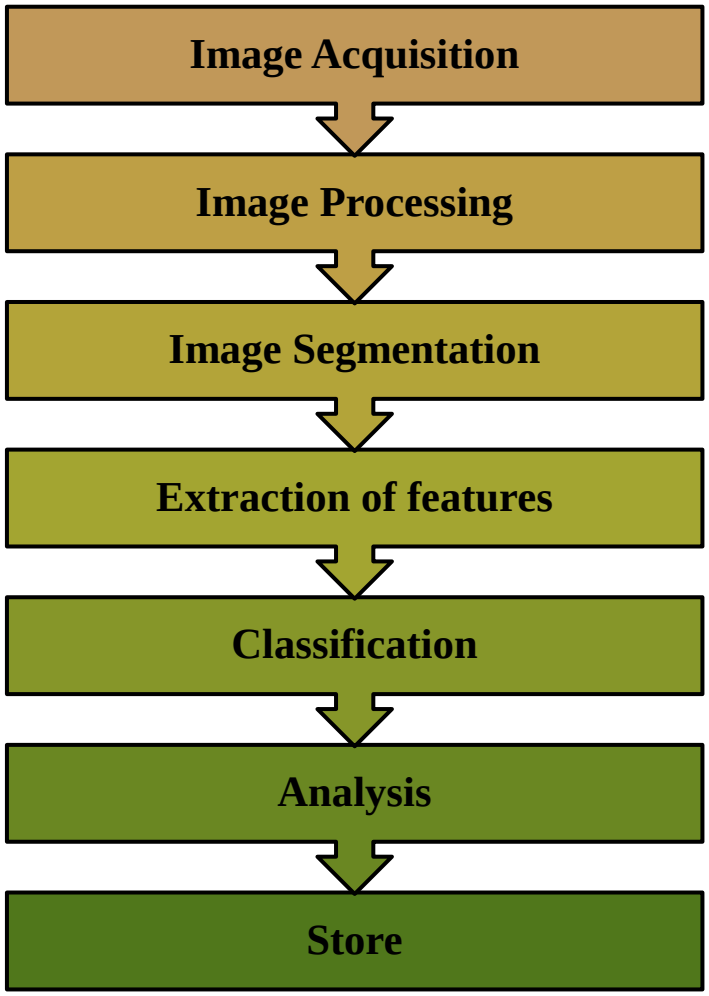
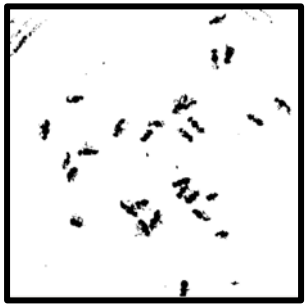
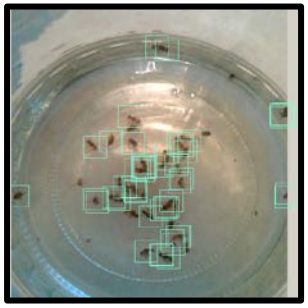
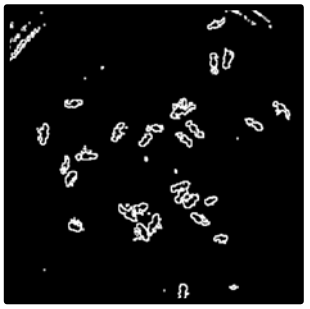
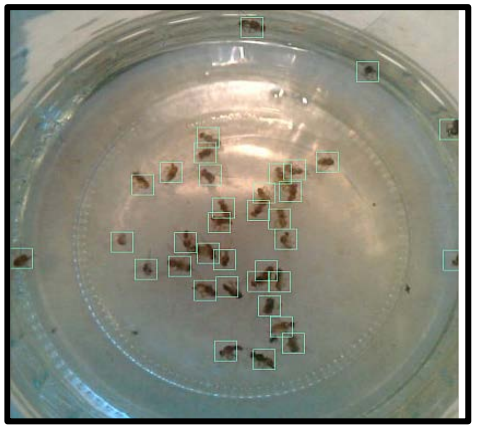
A DSS: Automatic insect counting











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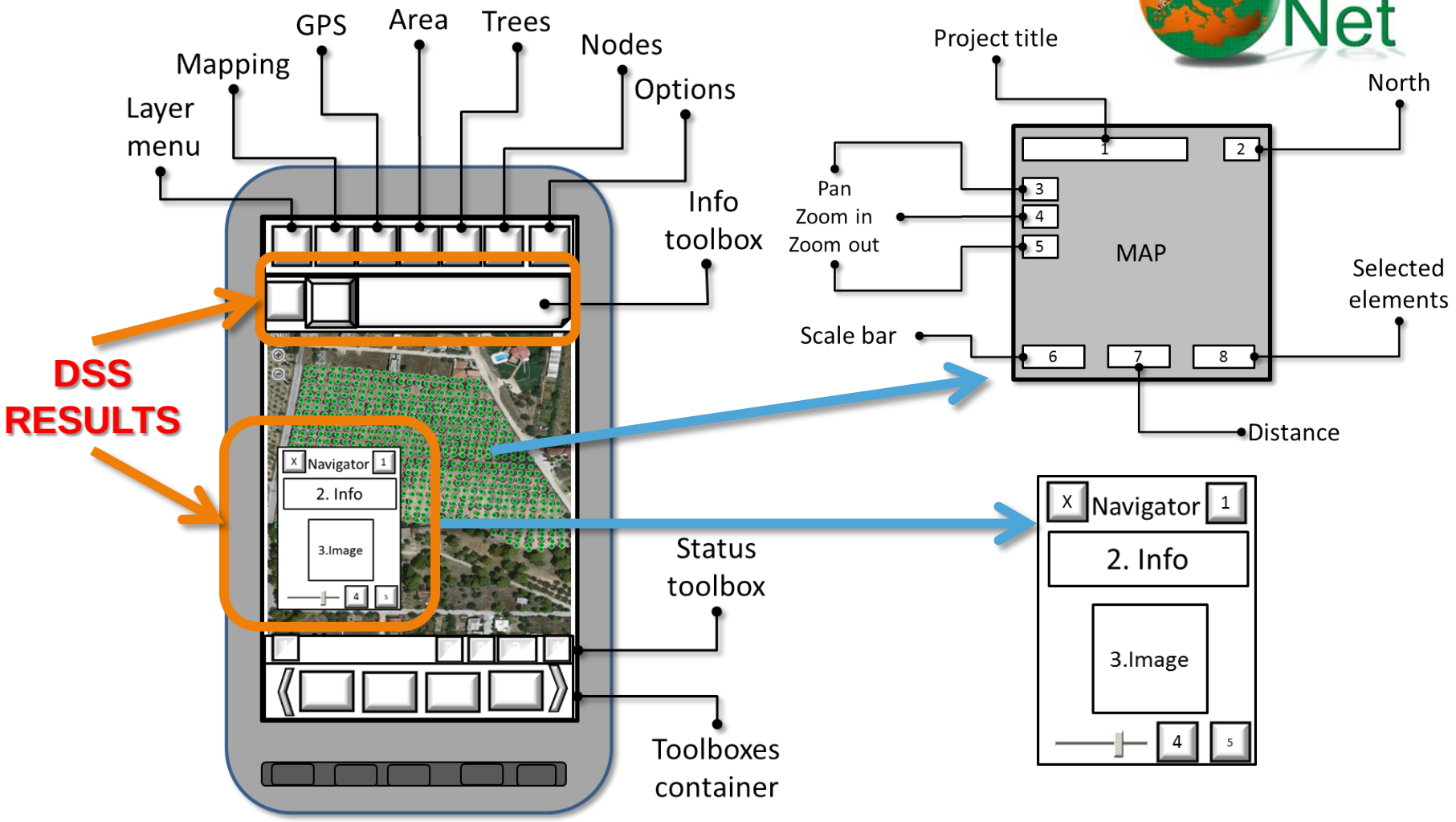
D. DSS how to spray using Mobile GIS



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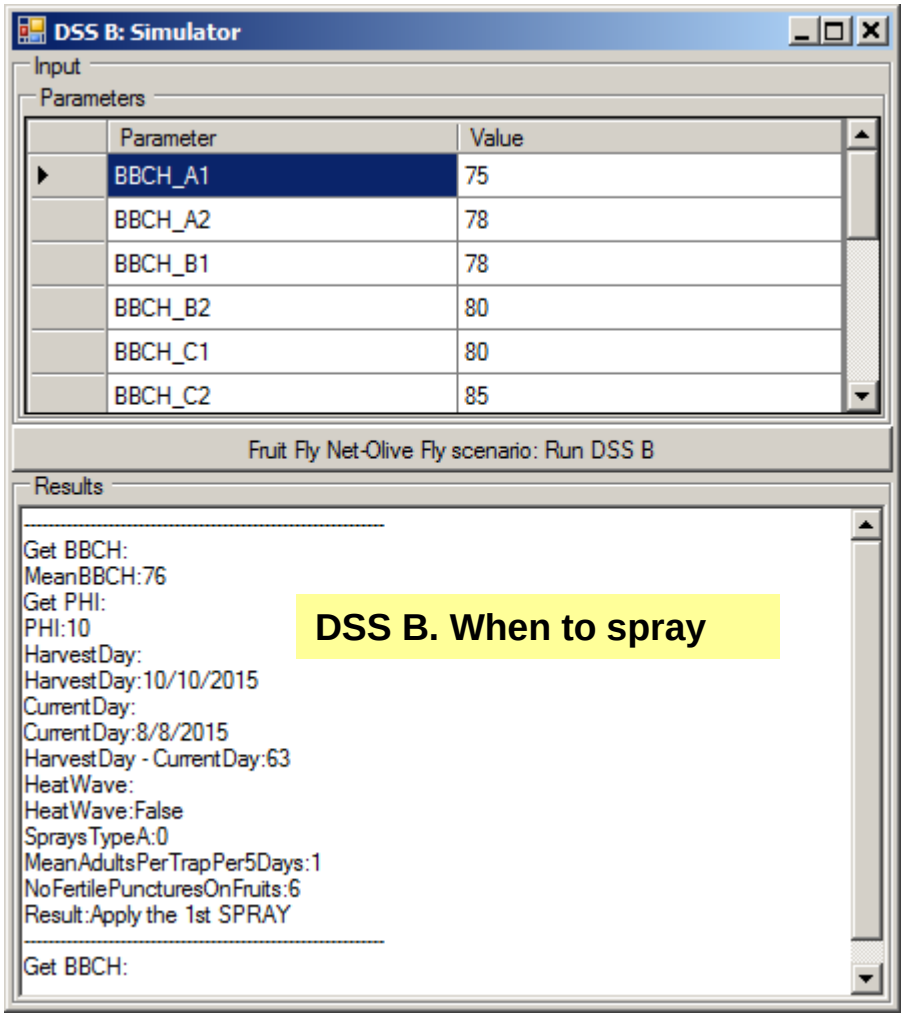
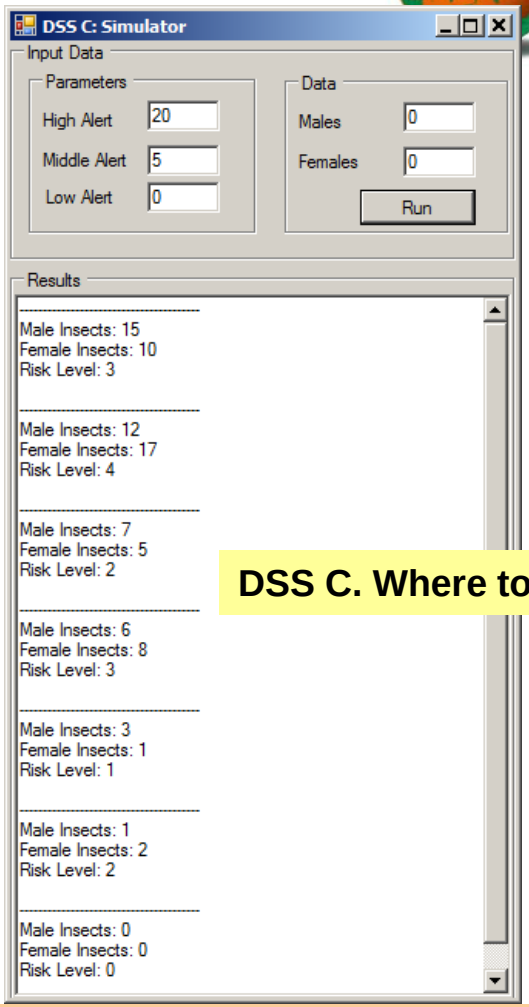
Simulators



DSS B. When to spray



DSS C. Where to spray

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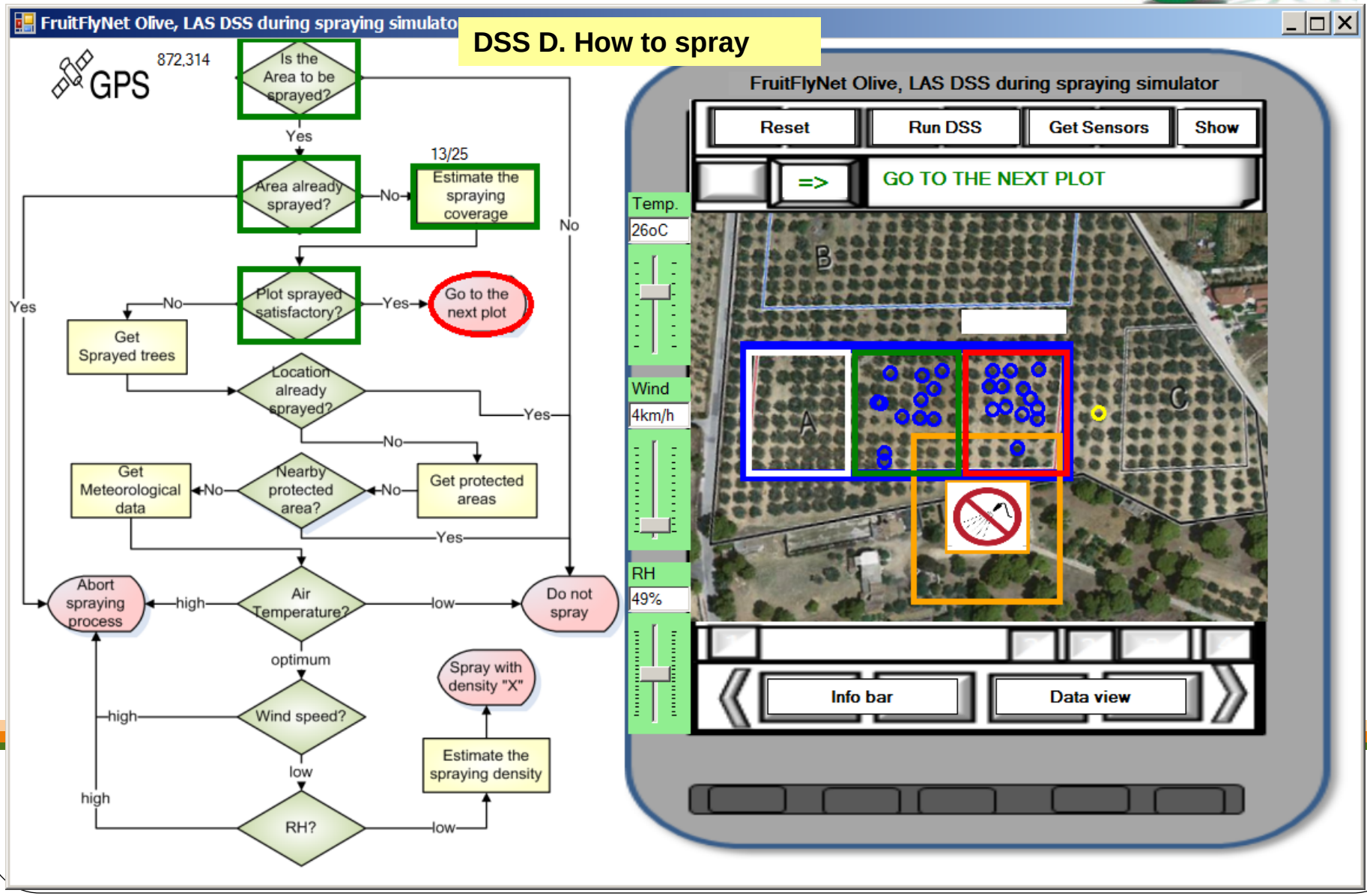
Simulators


FruitFlyNet Olive, LAS DSS during spraying simulato
DSS D. How to spray
GPS
872,314
Is the Area to be sprayed?
Yes
No
Area already sprayed?
No
13/25
Estimate the spraying coverage
Plot sprayed satisfactory?
No
Yes
Go to the next plot
Yes
Get Sprayed trees
Location already sprayed?
Yes
No
Get Meteorological data
No
Nearby protected area?
No
Get protected areas
Yes
Abort spraying process
high
Air Temperature?
low
Do not spray
optimum
Spray with density "X"
high
Wind speed?
low
Estimate the spraying density
high
RH?
low
FruitFlyNet Olive, LAS DSS during spraying simulator
Reset
Run DSS
Get Sensors
Show
=>
GO TO THE NEXT PLOT
Temp.
26oC
Wind
4km/h
RH
49%
A
B
C
Info bar
Data view

D. DSS how to spray (mobile GIS)

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Conclusions

- A DSS for olive fly bait spray applications was developed
- The components of the DSS were descripted
- Each DSS tested using specific simulators
- The Evaluation of each DSS will be performed using experimental methods and protocols

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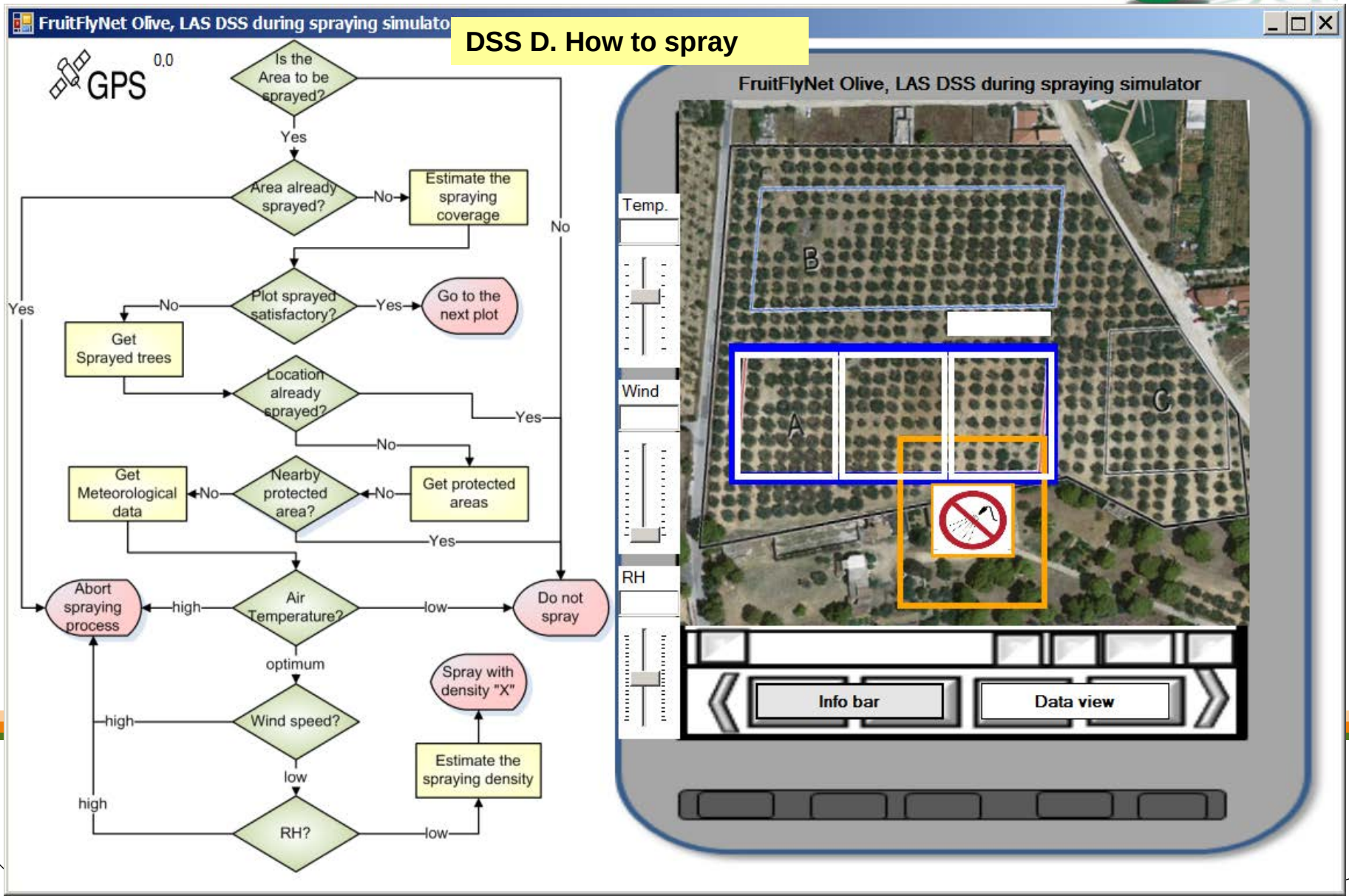
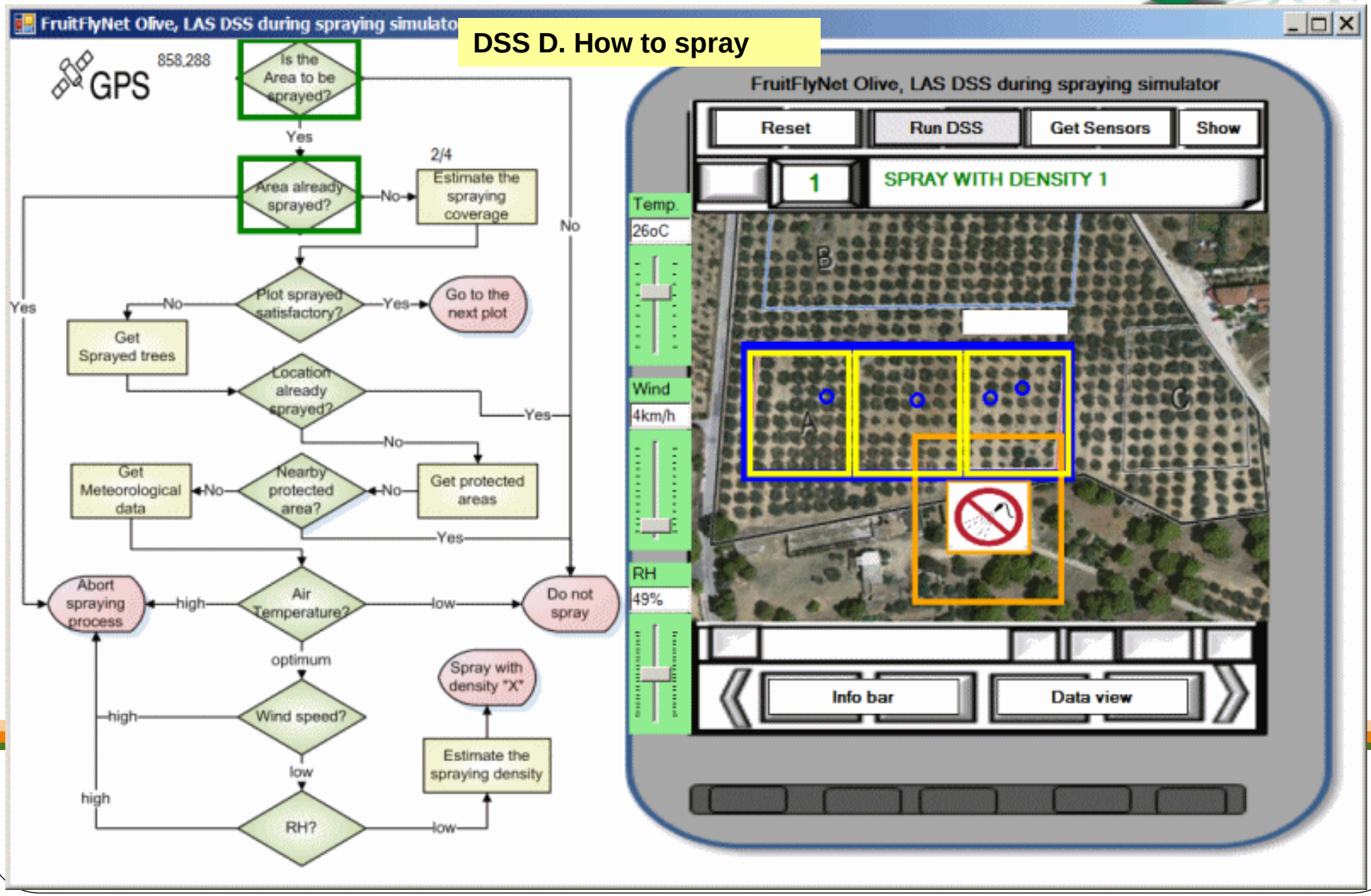
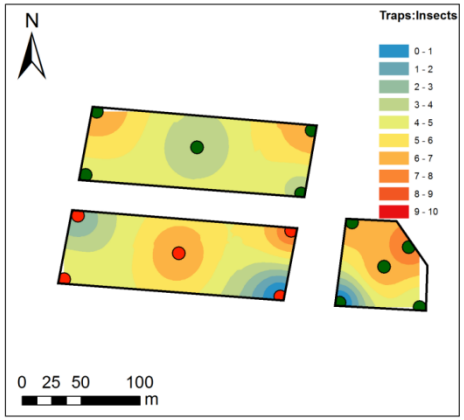
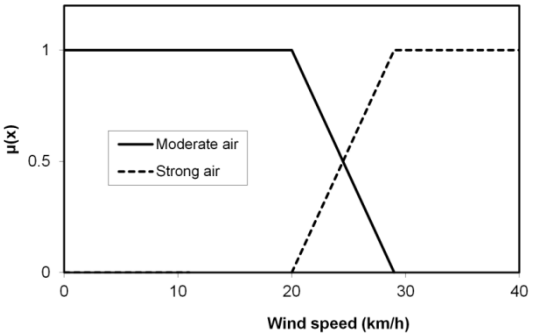
Simulators


FruitFlyNet Olive, LAS DSS during spraying simulato
DSS D. How to spray
GPS
0,0
Is the Area to be sprayed?
Yes
No
Area already sprayed?
No
Estimate the spraying coverage
Plot sprayed satisfactory?
No
Yes
Go to the next plot
Get Sprayed trees
Location already sprayed?
Yes
No
Nearby protected area?
No
Get protected areas
Get Meteorological data
No
Yes
Air Temperature?
high
low
Abort spraying process
Do not spray
optimum
Wind speed?
high
low
Spray with density "X"
Estimate the spraying density
RH?
high
low
FruitFlyNet Olive, LAS DSS during spraying simulator
Temp.
Wind
RH
A
B
C
Info bar
Data view

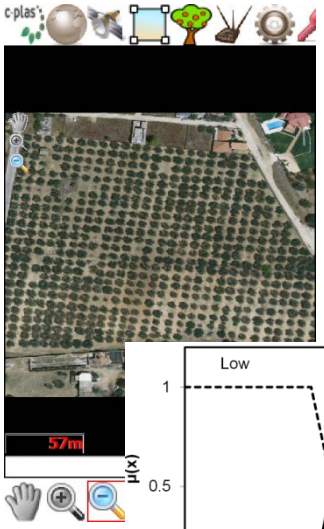
Simulators

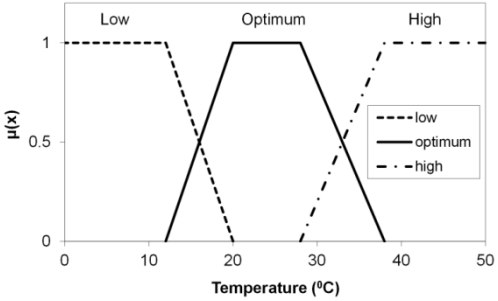

FruitFlyNet Olive, LAS DSS during spraying simulator
DSS D. How to spray
GPS
858.288
Is the Area to be sprayed?
Yes
No
2/4
Area already sprayed?
No
Estimate the spraying coverage
Plot sprayed satisfactory?
No
Yes
Go to the next plot
Get Sprayed trees
Location already sprayed?
Yes
No
Get Meteorological data
No
Nearby protected area?
No
Get protected areas
Yes
Abort spraying process
high
Air Temperature?
low
Do not spray
optimum
Spray with density "X"
high
Wind speed?
low
Estimate the spraying density
high
RH?
low
FruitFlyNet Olive, LAS DSS during spraying simulator
Reset
Run DSS
Get Sensors
Show
1
SPRAY WITH DENSITY 1
Temp.
26oC
Wind
4km/h
RH
49%
A
B
C
Info bar
Data view

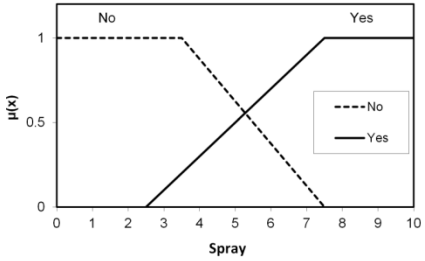


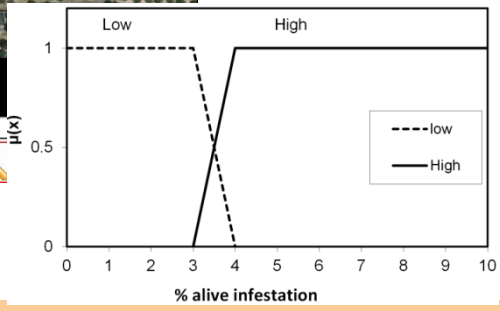


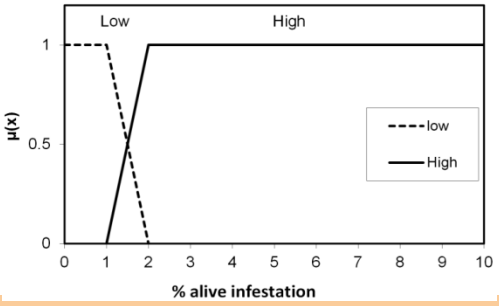
FruitFly

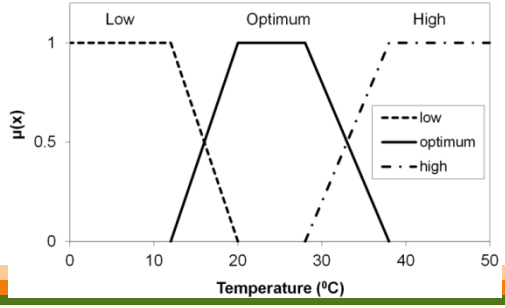












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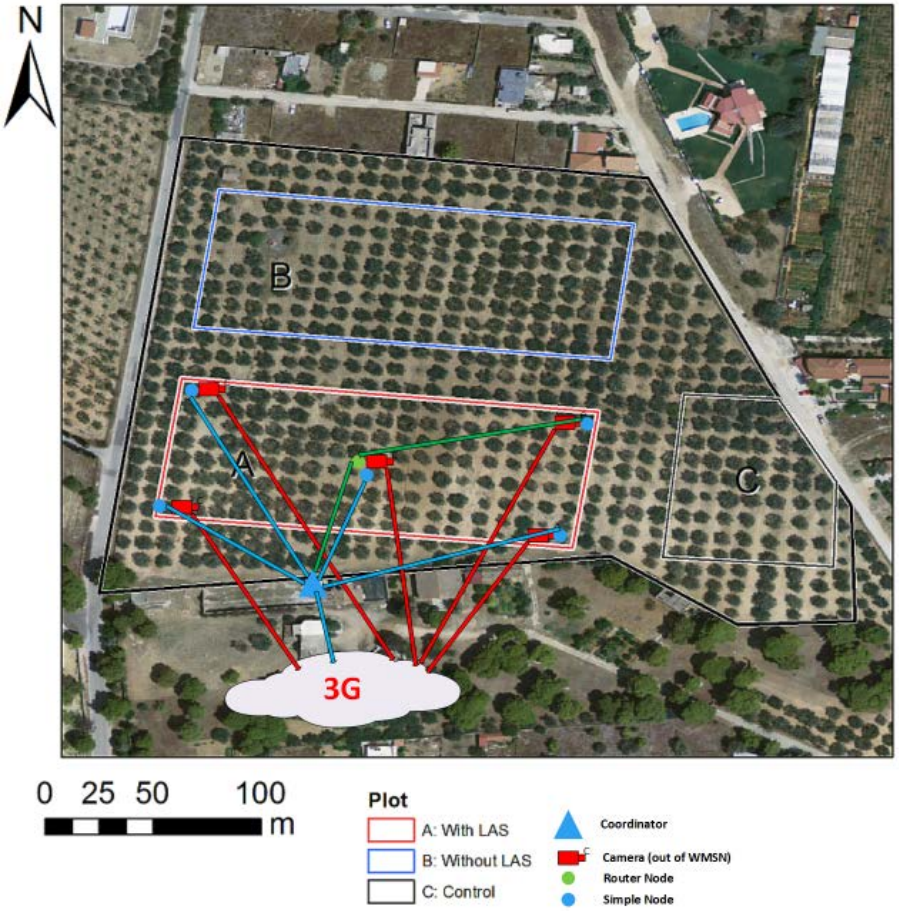
INPUT



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