

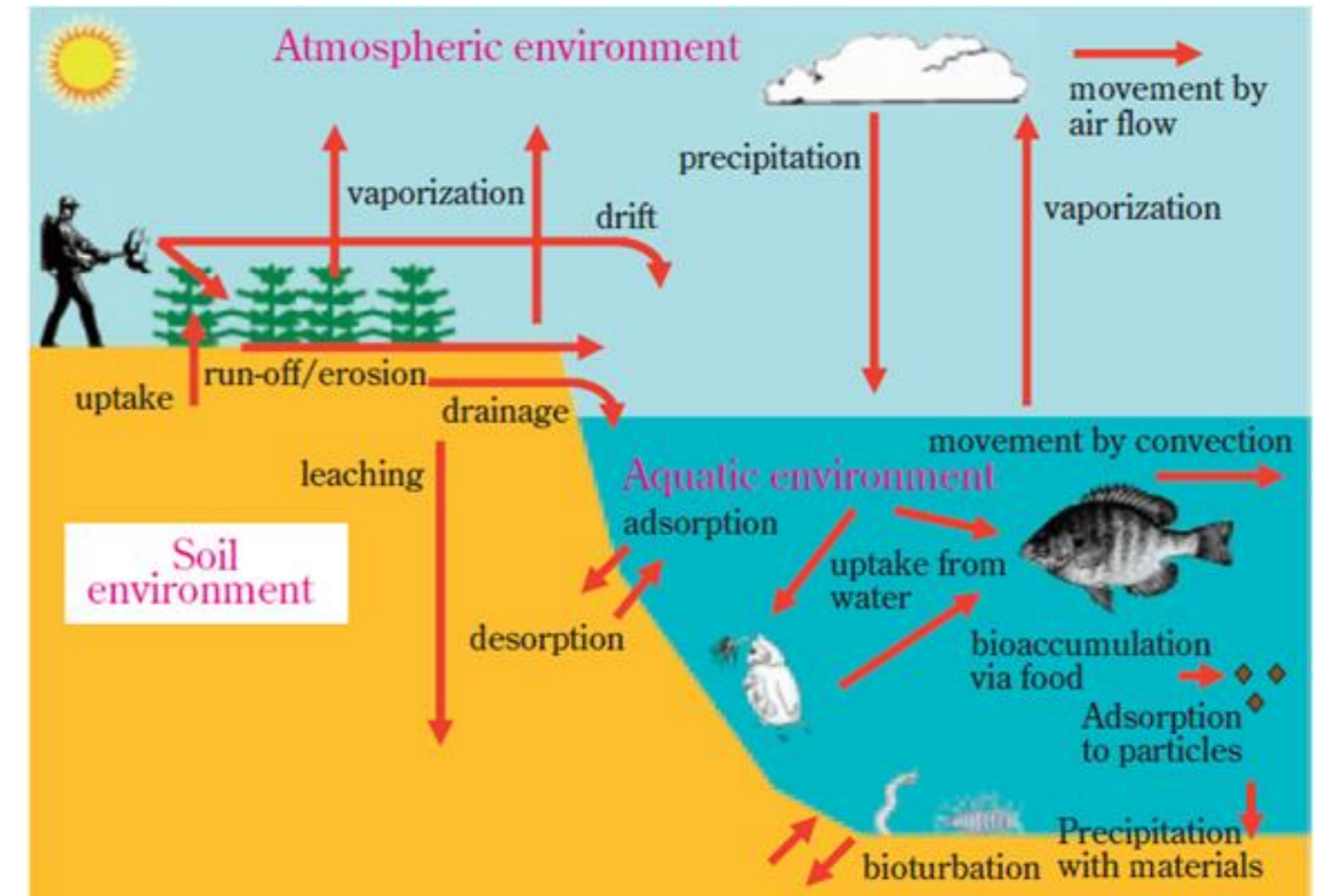
Distribution of agricultural pesticides in the freshwater environment of the Guayas river basin (Ecuador)

Arne Deknock, Niels De Troyer, Michael Houbraken, Luis Dominguez-Granda, Indira Nolivos, Wout Van Echelpoel, Marie Anne Eurie Forio, Pieter Spanoghe, Peter Goethals

2 October 2019

INTRODUCTION

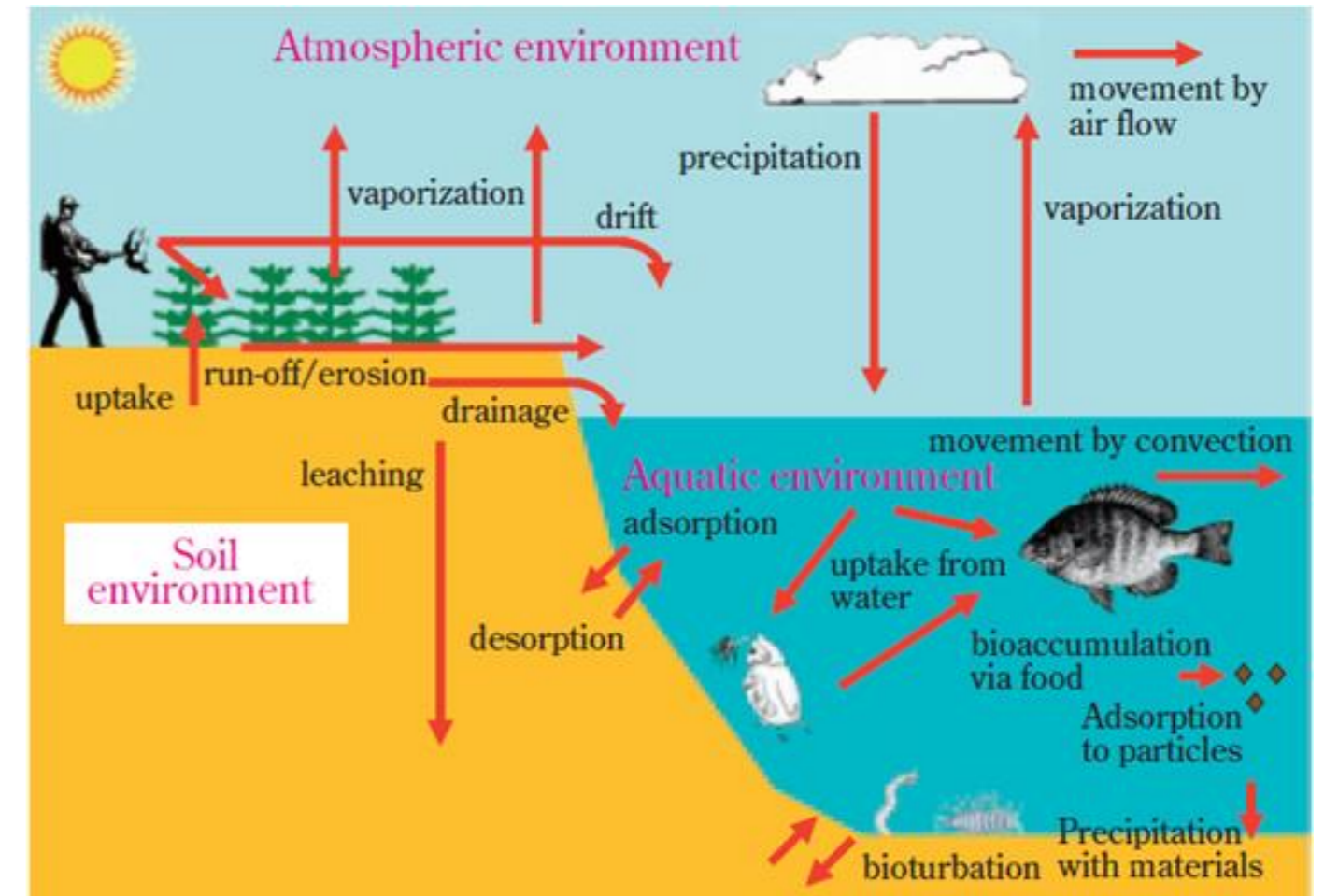
- Majority of applied pesticides ends up in environment
- Biologically active
- Developing regions:
 - Non-specific application methods



Miyamoto et al. (2008)

INTRODUCTION

- Majority of applied pesticides ends up in environment
- Biologically active
- Developing regions:
 - Non-specific application methods
 - Cheap products (e.g. persistent organochlorines)
 - Lack of training, technical services, regulations and control
 - Low awareness and integration of rational pest management strategies
 - Pressure by multinationals



Miyamoto et al. (2008)

INTRODUCTION

- Majority of applied pesticides ends up in environment
- Biologically active
- Developing regions:

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A Delaware federal magistrate judge has denied produce company Chiquita's request to be let out of litigation concerning Ecuadorean farm workers' claims that they were poisoned from exposure to pesticides used on bananas.

By P.J. D'Annunzio juli 17, 2019 at 02:52 PM

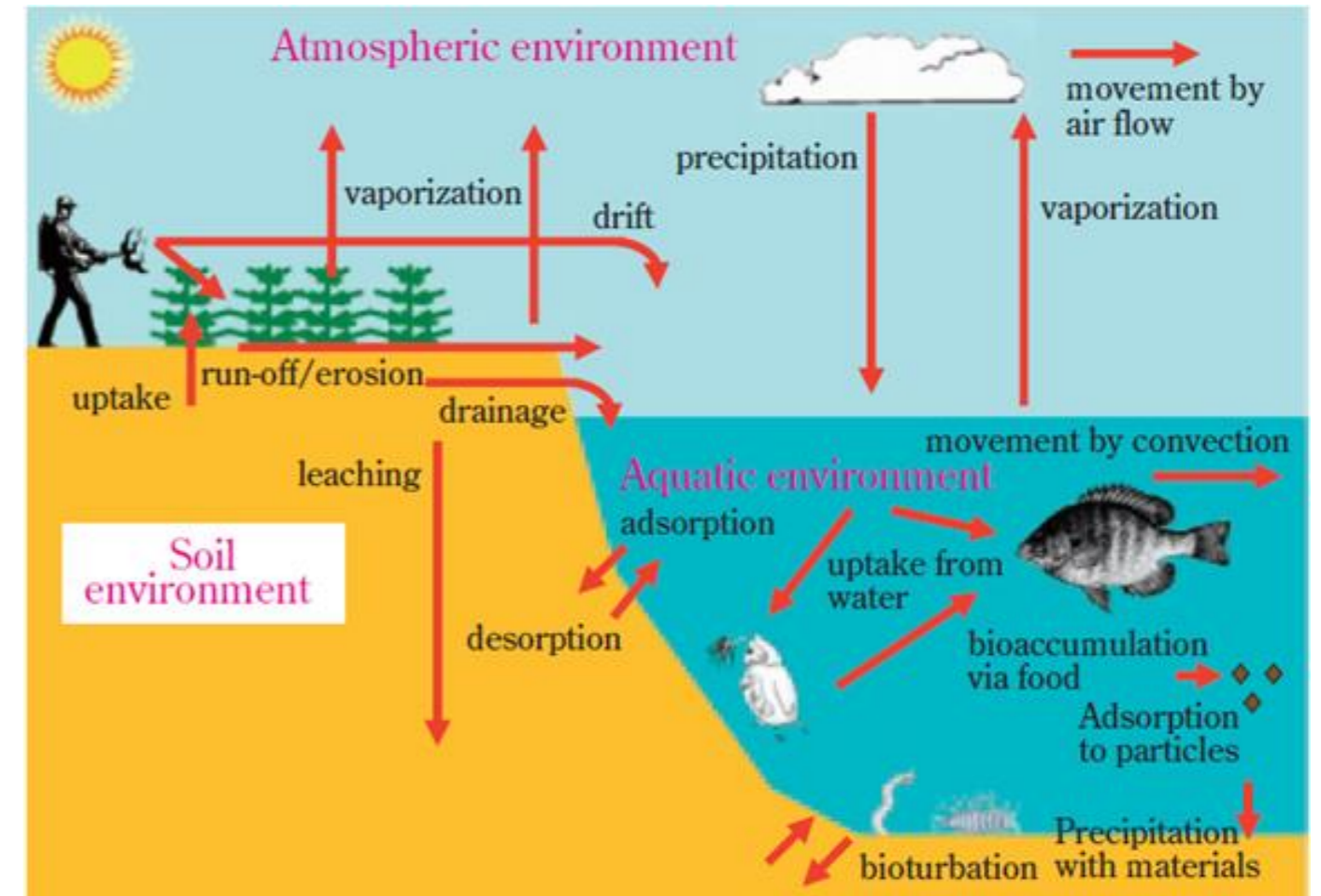


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Miyamoto et al. (2008)

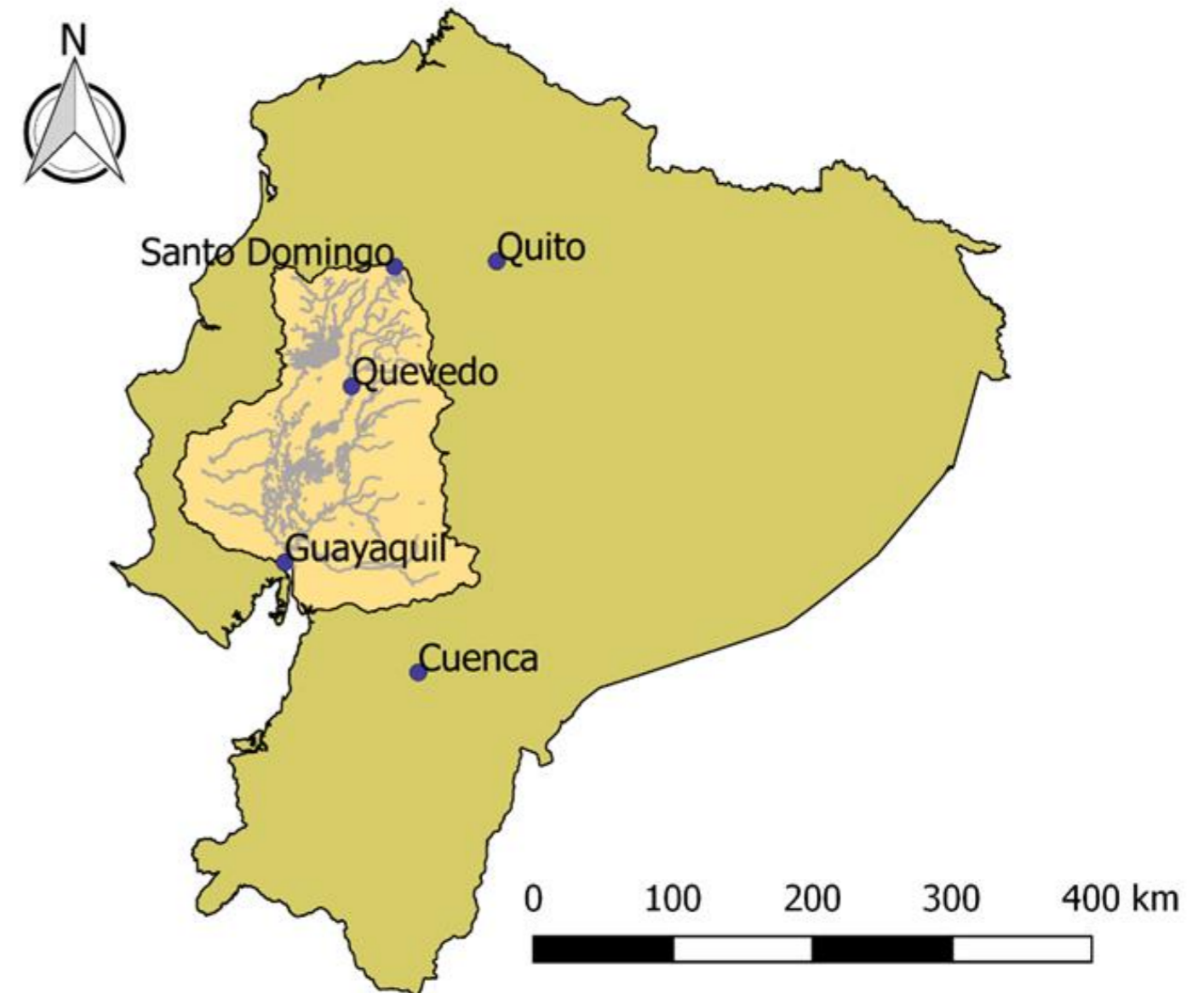
INTRODUCTION

- Ecuador

- largest export-based banana industry
- 34,317 metric tons of active ingredients per year (2014-2017)

- Guayas river basin

- 40% of national population (2002)
- 68% of national crop production (1996)
- 88% of Ecuadorean bananas (1996)

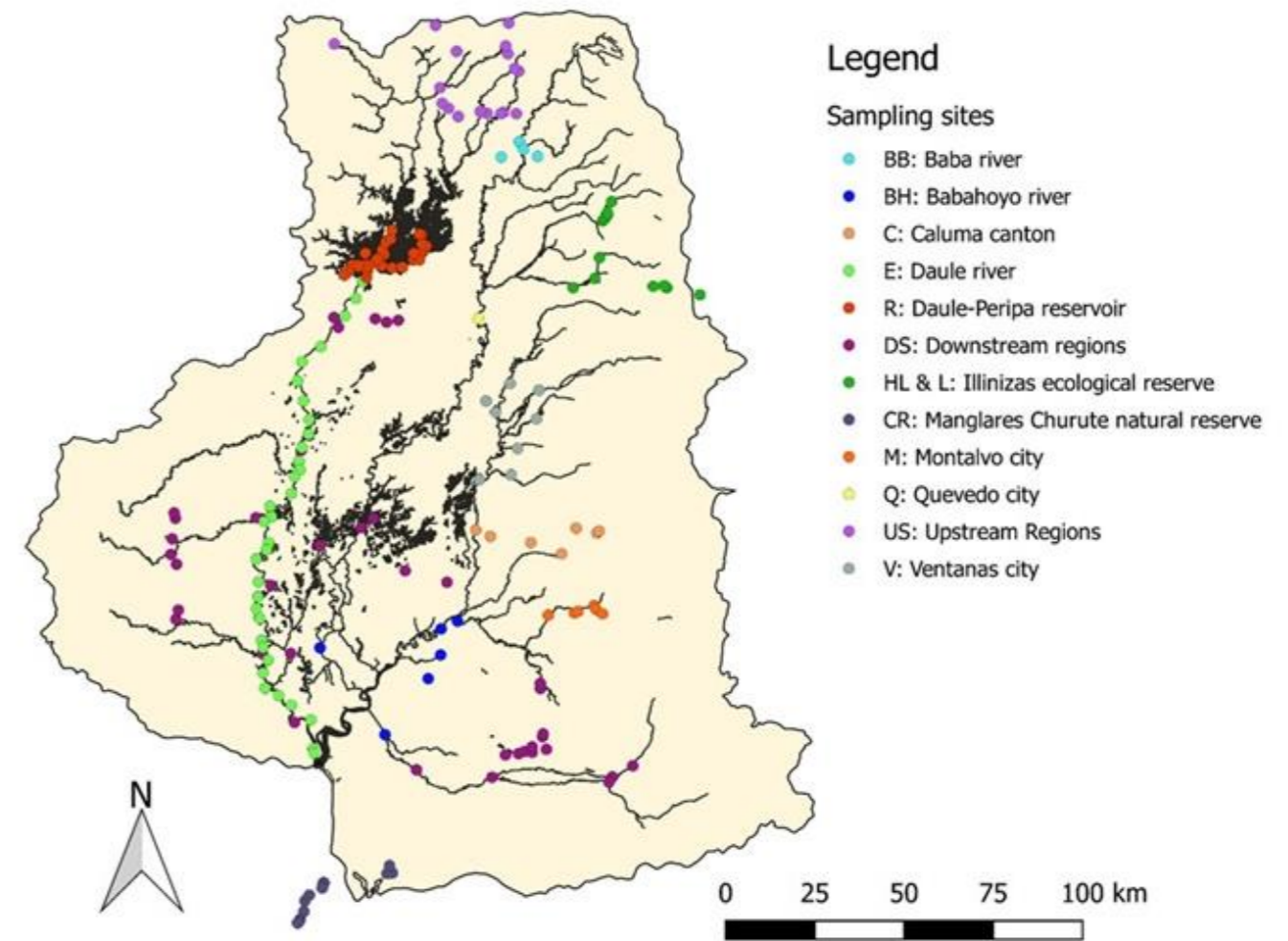


OBJECTIVES

1. Pesticide residues within the Guayas river basin?
2. Link with agricultural land use?

METHODOLOGY

- July and August 2016
- 181 sampling locations
 - 31 Daule-Peripa reservoir
 - 15 Manglares Churute natural reserve
 - Including upstream, downstream, natural and clearly affected locations
- Selection of 83 relevant products
- Solid-phase extraction (SPE)



Sep-Pak®
Sample Extraction Products



METHODOLOGY

- Gas chromatography with electron capture detector (GC-ECD) and liquid chromatography tandem-mass spectrometry (LC-MS/MS)



LC-MS/MS



GC-ECD

- Validation: spike-placebo recovery method

OBJECTIVES

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RESULTS & DISCUSSION

- 26 products
- 108 contaminated sites (60%)
- Highest product diversity:
 - Daule river (E-series): 8 products
 - Babahoyo river (BH-series): 7 products
- Downstream region more polluted
- No impact on biological diversity
- Note:
 - Single time point
 - Other compartments?

Pesticide	# locations	Concentration range ($\mu\text{g}\cdot\text{L}^{-1}$)	Recovery (%)
Acephate	3	<LOQ	58.21 \pm 1.60
Ametryn	1	<LOQ	81.49 \pm 5.54
Boscalid	2	<LOQ	97.59 \pm 4.88
Butachlor	21	<LOQ – 2.006	78.10 \pm 21.77
Cadusafos	62	<LOQ – 0.081	61.73 \pm 6.12
Chlorpyrifos	5	<LOQ – 0.035	62.70 \pm 9.16
Diazinon	3	<LOQ	63.10 \pm 28.24
Fenpropimorph	15	0.022–0.241	98.27 \pm 22.26
Linuron	6	<LOQ	98.50 \pm 30.85
Malathion	12	<LOQ – 0.687	119.83 \pm 6.60
Metalaxyl	3	<LOQ	99.75 \pm 6.87
Oxadiazon	2	0.068–0.120	108.80 \pm 27.35
Parathion	1	<LOQ	105.03 \pm 6.48
Pendimethalin	21	0.170–0.557	94.97 \pm 11.40
Pyraclostrobin	1	<LOQ	44.31 \pm 13.75
Pyrimethanil	11	<LOQ – 0.080	47.92 \pm 6.41
Spiroxamine	1	0.099	82.85 \pm 7.30
Tebuconazole	1	0.316	61.34 \pm 2.94
Terbutryn	1	<LOQ	76.78 \pm 6.32
Triadimenol	1	0.092	64.50 \pm 13.83

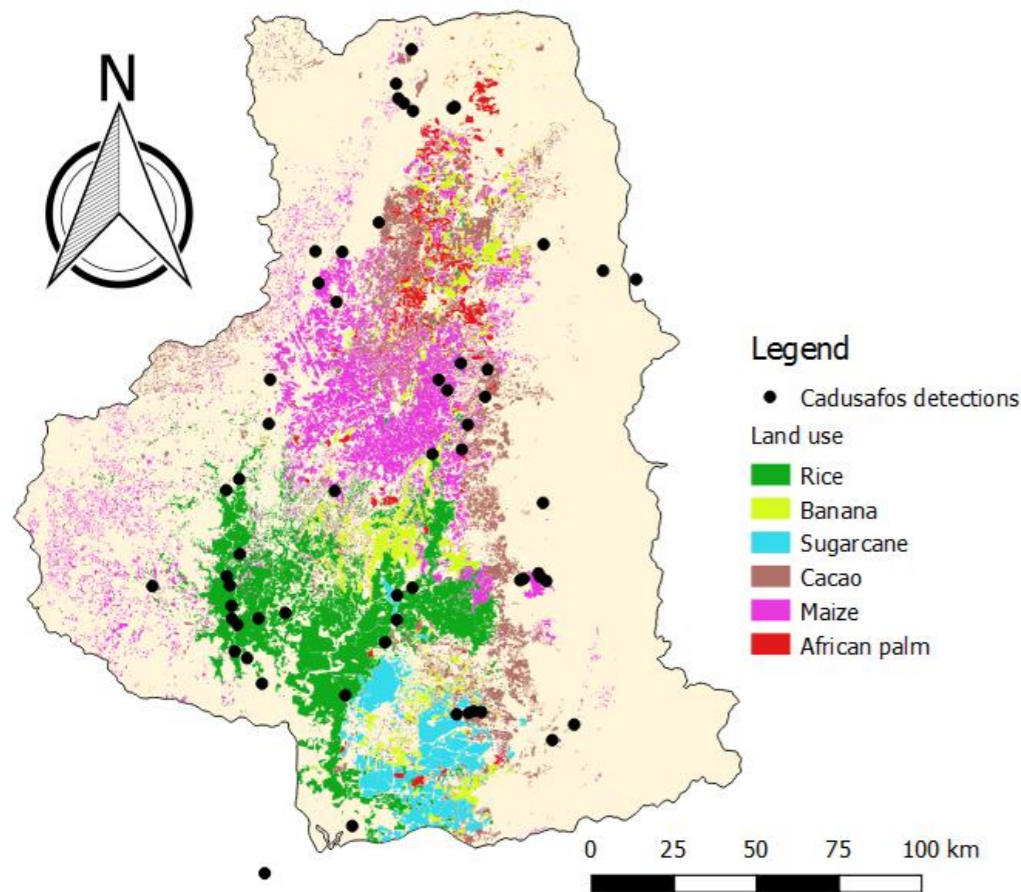
^a LOQ = 0.022 $\mu\text{g}\cdot\text{L}^{-1}$ for all mentioned pesticides.

OBJECTIVES

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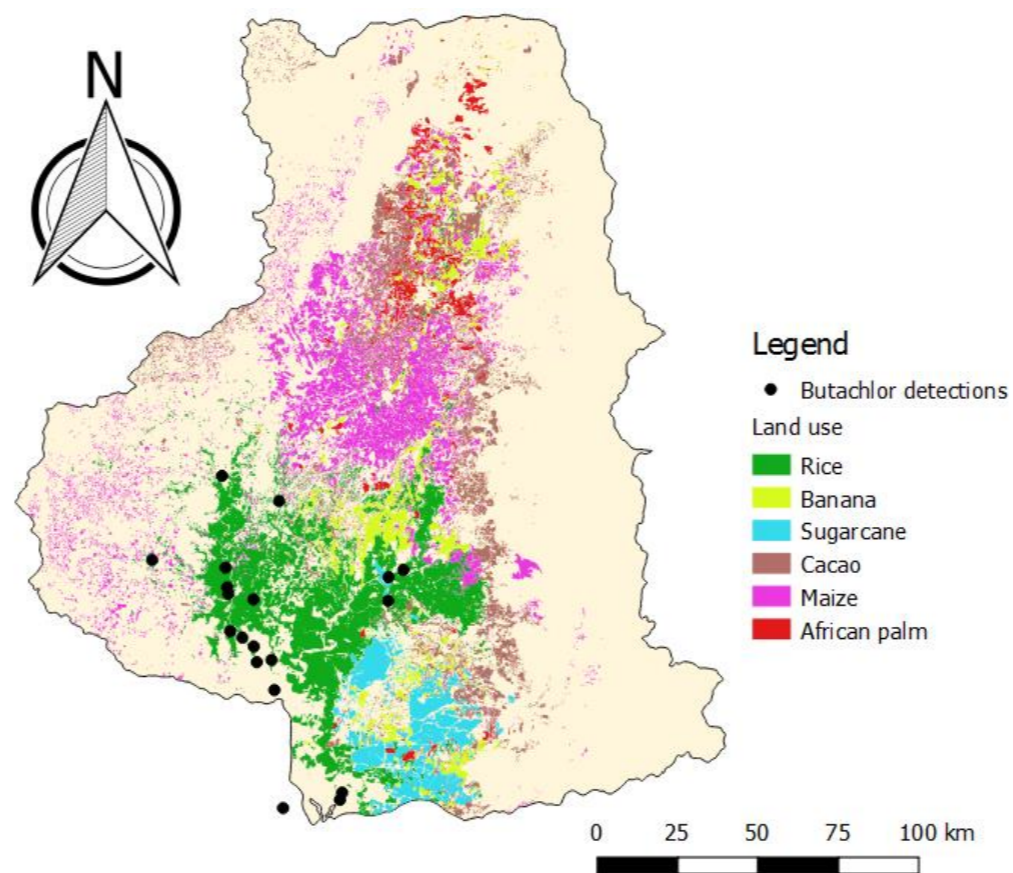
RESULTS & DISCUSSION

Cadusafos (62 sites)



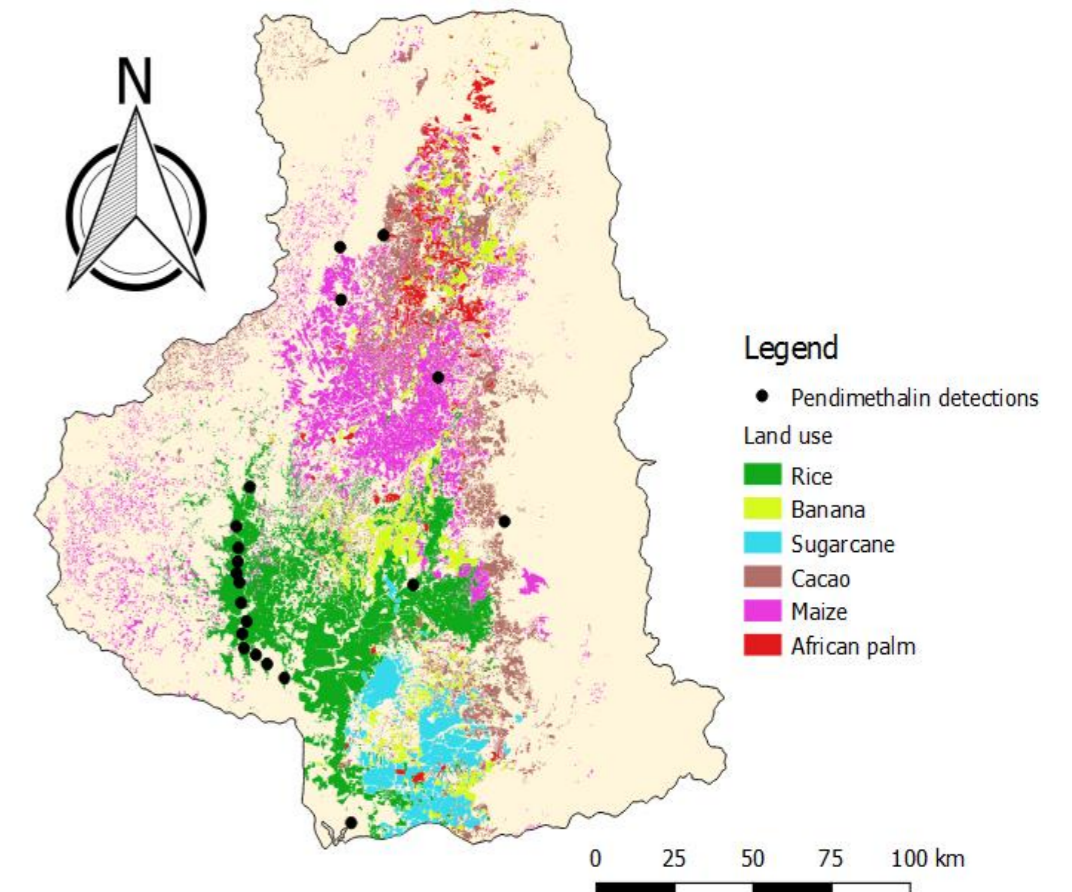
- Widely spread
- Frequently used insecticide in **banana** industry
- Slow degradation: DT50 = 215 d
- Relatively mobile: S = 245 mg/L, K_{oc} = 227 L/kg

Butachlor (21 sites)



- Concentrated in **rice** field areas
- Commonly used herbicide in cereal cultivation to control grassy weeds
- Very immobile: S = 20 mg/L, K_{oc} = 700 L/kg

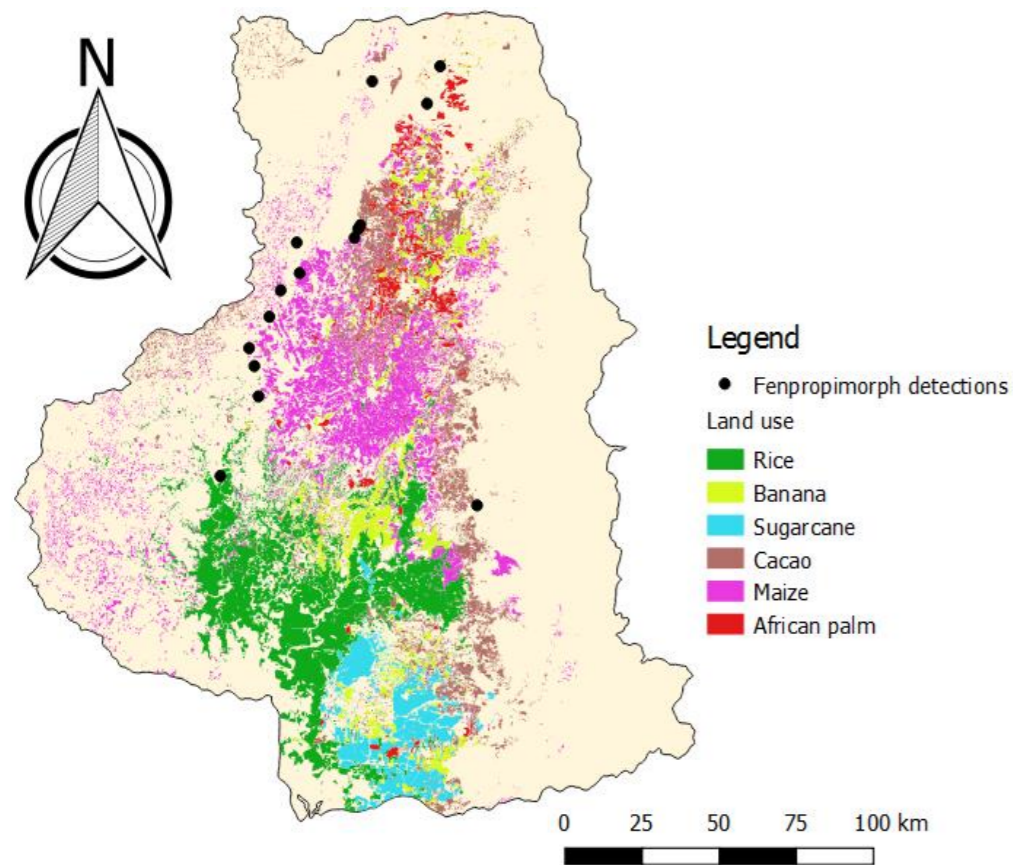
Pendimethalin (21 sites)



- Daule river
- Mainly detections in **rice** field areas, and few near maize and cacao
- Commonly used herbicide in cereal cultivation to control grassy weeds
- Very immobile: S = 0.33 mg/L, K_{oc} = 17,491 L/kg

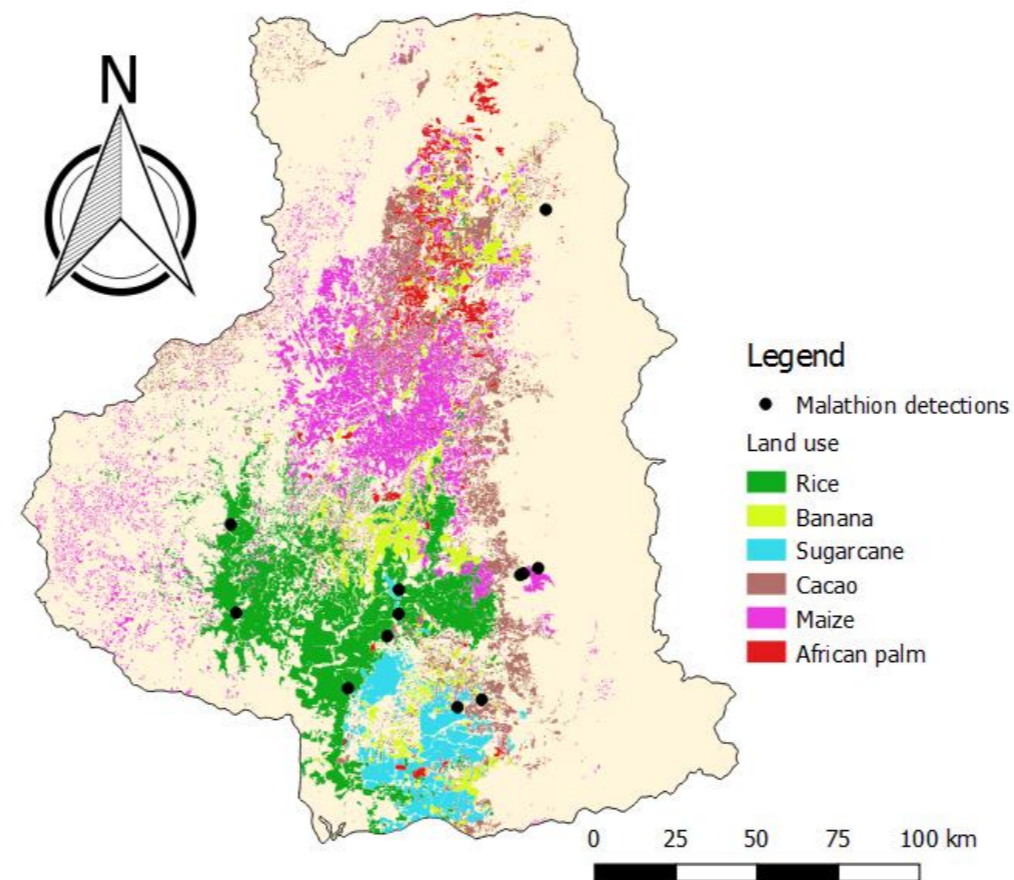
RESULTS & DISCUSSION

Fenpropimorph (15 sites)



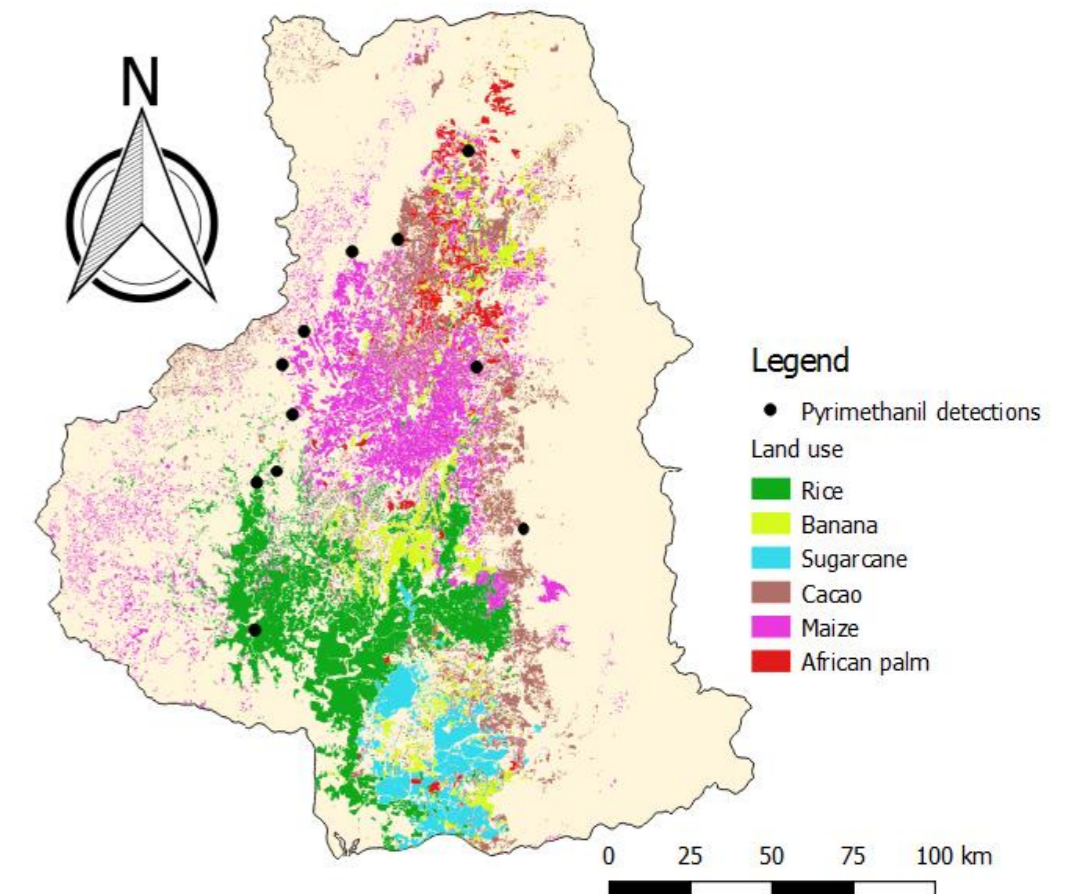
- Upstream region near **maize** and cacao, infiltrated with **banana** plantations
- Frequently used fungicide in cereal and banana industries
- No physicochemical data

Malathion (12 sites)



- Downstream region (Babahoyo river)
- Broad-spectrum insecticide
- Very fast degradation: $DT_{50} = 0.4$ d
- Slightly mobile: $S = 148$ mg/L, $K_{oc} = 1,800$ L/kg

Pyrimethanil (11 sites)



- Widely spread
- Broad-spectrum fungicide
- No physicochemical data

RESULTS & DISCUSSION

- Pesticide residues ↔ agricultural land use
- Banana and rice
- High consumption rates
- Application methods
- Alternatives and solutions?
 - Ground-based spraying systems
 - Avoid monocultures (agroforestry)
 - Integrated Pest Management strategy (IPM)
 - Legal regulations + control
 - Awareness campaigns + training
 - Policy changes multinationals



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CONCLUSIONS

- Pesticide residues widely present in Guayas river basin
 - No impact on biological diversity
 - Only water phase: other compartments?
 - Single time point: rainy season? Production cycles?
- Frequently detected (>10 sites) were linked with agricultural land use
 - Banana and rice
 - High consumption rates + application methods
 - Alternatives: changing cultivation methods, awareness campaigns, training programs, regulatory measures, policy changes from multinationals

Arne Deknock

Doctoral student

AQUATIC ECOLOGY (AECO)

arne.deknock@ugent.be

www.ugent.be

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