

Modirisk: Mosquito vectors of disease, collection, monitoring and longitudinal data from Belgium

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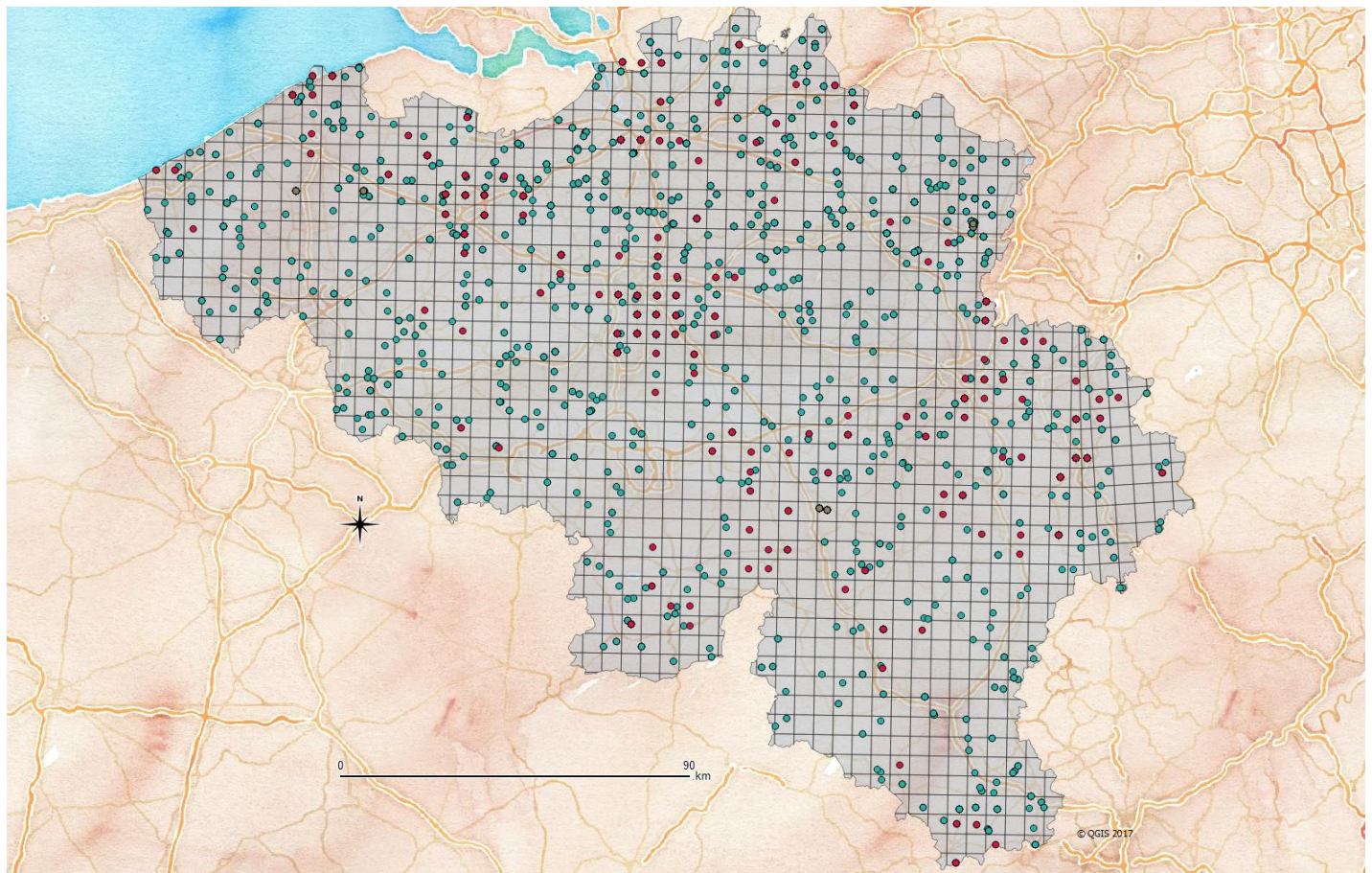
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Abstract

The MODIRISK project aims at studying biodiversity of mosquitoes and monitoring/predicting its changes, and hence actively prepares to address issues on the impact of biodiversity change with particular reference to invasive species and the risk to introduce new pathogens (Versteirt, 2009). This is essential in the perspective of the ongoing global changes creating suitable conditions for the spread of invasive species and the (re)emergence of vector-borne diseases in Europe. The main strengths of the Modirisk project in the context of sustainable development are the links between biodiversity and health-environment and its contribution to the development of tools to better describe the spatial distribution of mosquito biodiversity. MODIRISK addresses key topics of the global initiative Diversitas, which was one of the main drivers of the 'Research programme Science for a Sustainable Development' from the Belgian funding agency Belspo (www.belspo.be). 3 Different Modirisk datasets were published on GBIF 1) The Collection dataset, which contains the Culicidae collection in the Museum of Natural History RBINS in Brussels. 2) The monitoring dataset, which holds the data of the Modirisk inventory effort and the longitudinal dataset holding experiment data used for risk assessments.

Rationale

Mosquito-borne diseases are prime candidates as (re)emerging vector-borne disease in Europe. Knowledge of the taxonomic and functional biodiversity of both endemic and invading mosquito species as well as the factors driving changes was missing in Belgium. Acquiring this knowledge is an essential step towards understanding current risk and preparing action plans for future threats. Therefore the objectives of MODIRISK were (1) to inventorize endemic and invading mosquito species in Belgium considering environmental and taxonomic elements of biodiversity (Collection dataset), (2) to assess the population dynamics of selected endemic and invasive mosquito species and their interrelationship (Longitudinal dataset) (3) to model mosquito biodiversity distribution at a 1km resolution, (the Inventory) and (4) to disseminate project outputs. The 3 datasets, originated during the Modirisk project, were standardized to Darwin Core (Wieczorek, 2012) and published by the Royal Belgian Institute for Natural Sciences (RBINS) through the Integrated Publishing Toolkit or IPT (Robertson, 2014) of the Belgian GBIF node.



Overview of all the Modirisk occurrence data

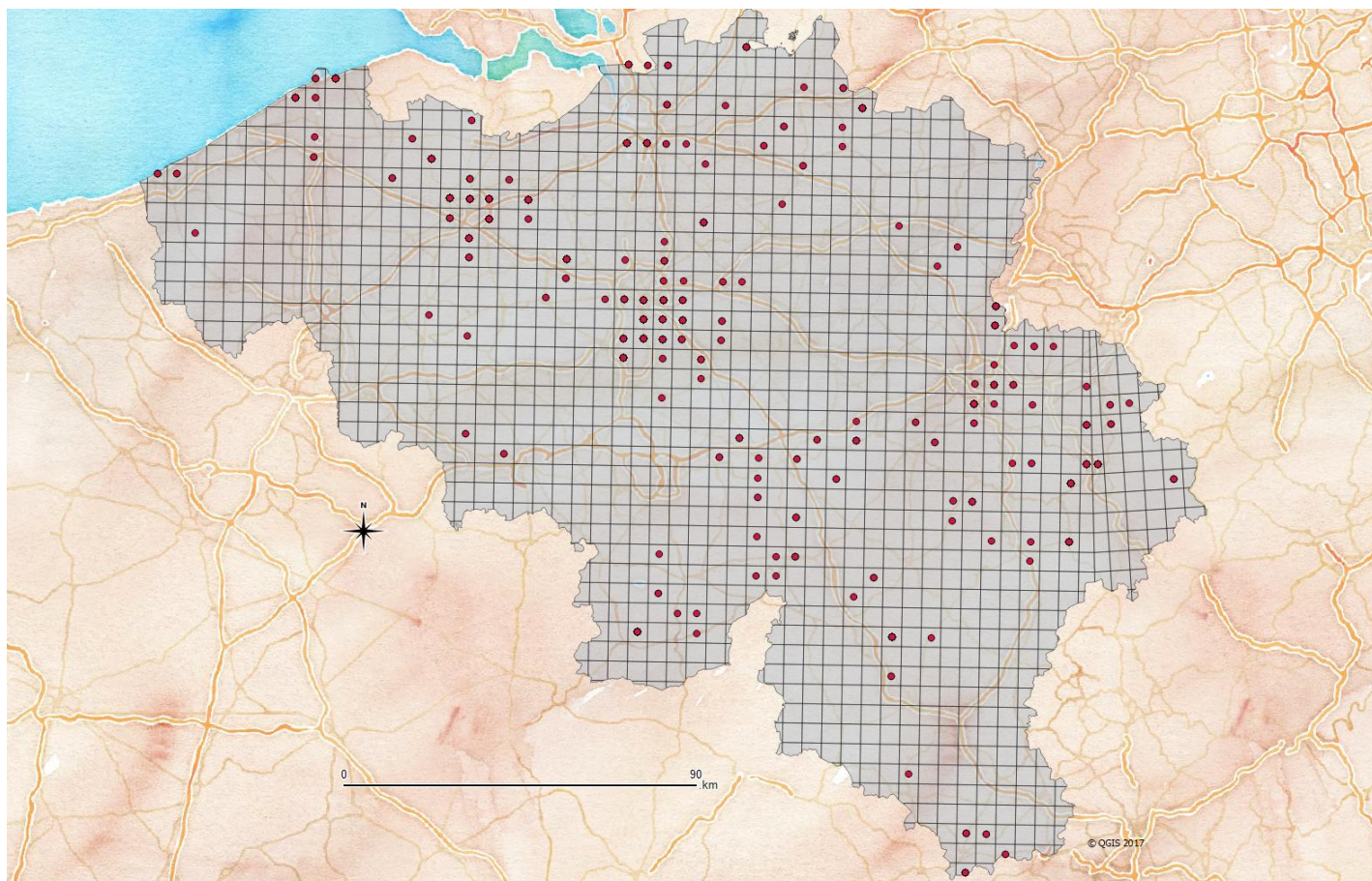
The collection dataset^[1], dealing with both historic and recent Culicidae specimens, the Monitoring dataset^[2], dealing with the current inventory of Culicidae in Belgium and the longitudinal study dataset^[3], dealing with questions about risk assessment, outbreaks, possible distribution etc. are 3 different datasets developed in the Modirisk project. These 3 datasets are closely linked but are published as 3 different Darwin Core Archives.

During the first phase (years 2007-2008), the project focused on the inventory activities; setting-up laboratory experiments for studying life history traits of *Culex pipiens* in relation to temperature and the first selection of models based on the field results. Whilst during the second phase of the project (years 2009-2010) the focus was on the spatial model building and validation, on the longitudinal study and dynamics of selected indigenous and exotic species that were found during the inventory of the first phase and on more population genetic driven research.

The project was coordinated by the Institute of Tropical Medicine(<http://www.itg.be/E>) in Antwerp.

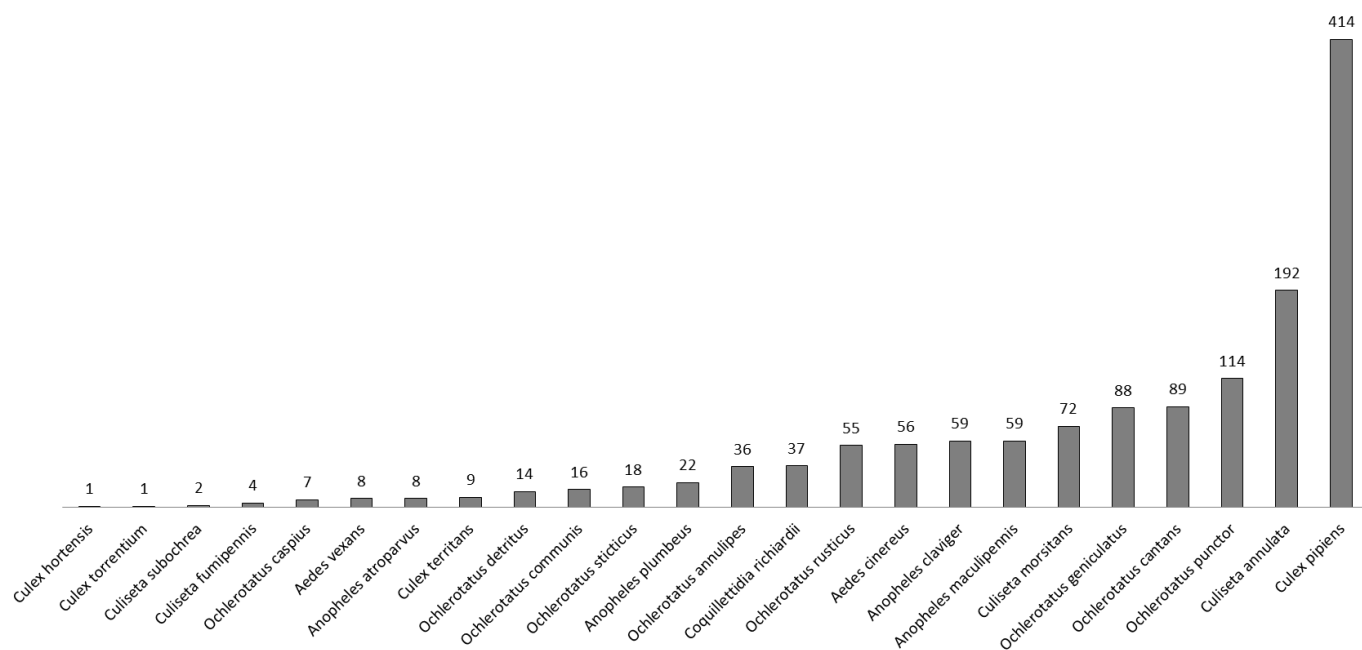
The Collection dataset

The Culicidae collections dataset (<http://www.gbif.org/dataset/3331bcd4-f85e-4252-8e92-3aaa6fdc3eca>) is a part of the invertebrate of the Royal Belgian Institute of Natural Sciences (RBINS) collection. The Collection `RBINS:Invertebrates` is incredibly diverse, containing sponges, corals, starfish, crustaceans, jellyfish, rotifers, leeches, insects and many more. For an overview of the RBINS collection we refer to the RBINS DarWin database (doi:10.15468/qxy4mc). About 1400 mosquito-specimens from the Belgian collection of the Entomology Department were screened and added to the Modirisk Collection dataset. All voucher specimens from the available collections were re-identified at the species level using Schaffner et al., 2001.



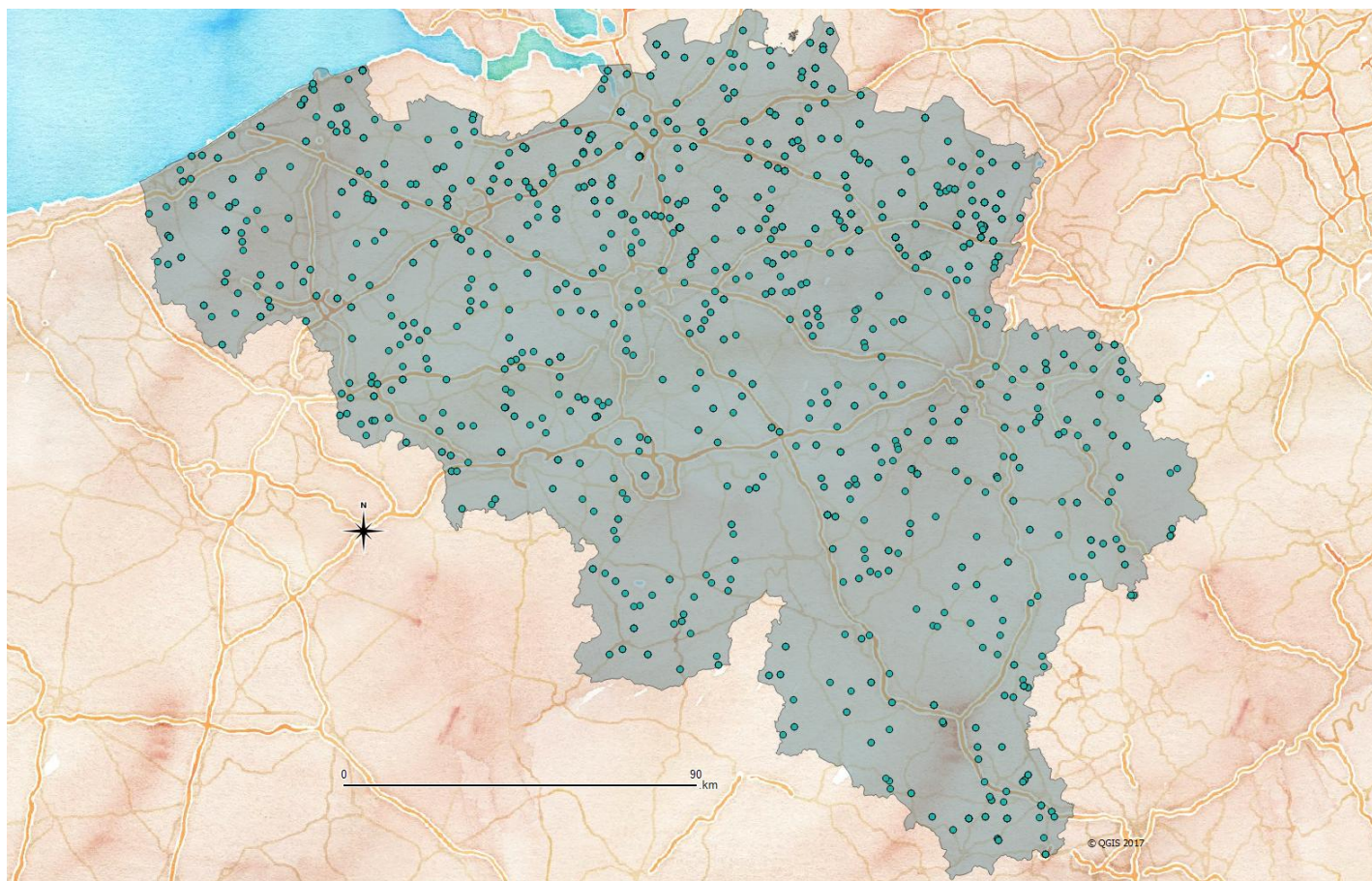
Modirisk RBINS Collection data

Occurrence Count RBINS Collection

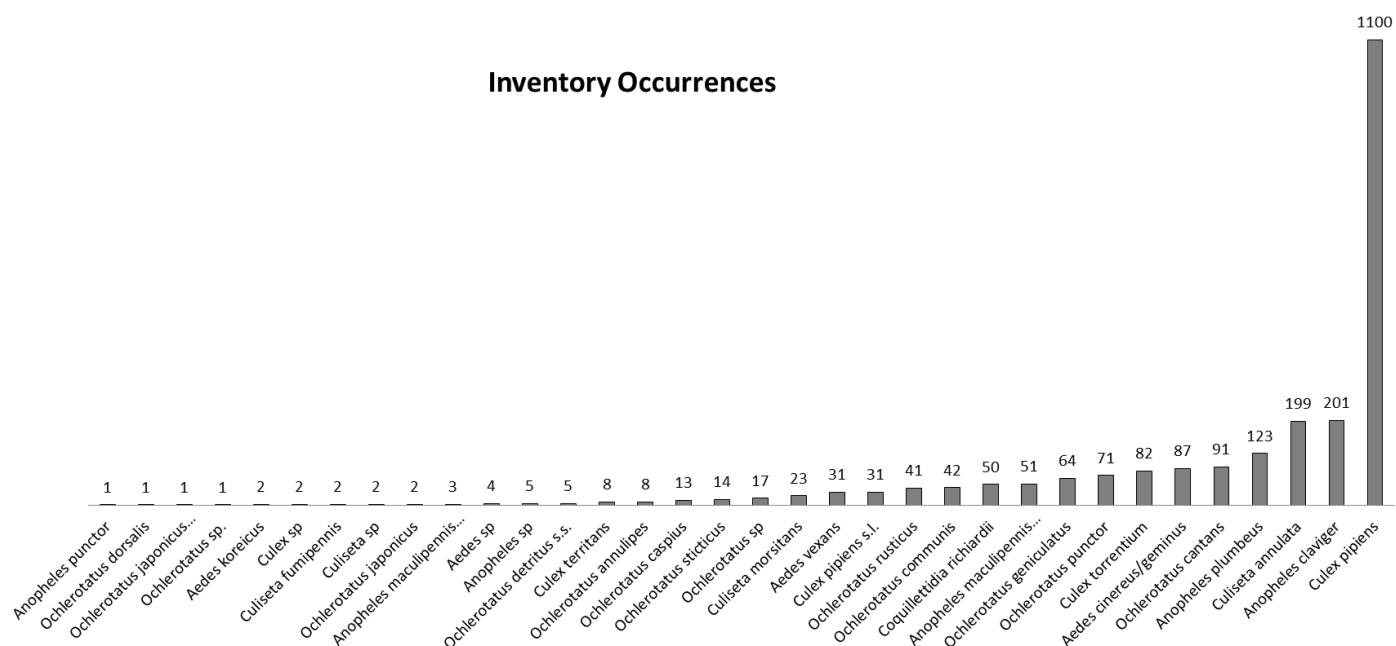


The Inventory

The Culicidae inventory dataset (<http://www.gbif.org/dataset/6679952f-649b-4888-bd97-00daca4b8cc1>) was created by a cross sectional field survey in 2007 and 2008 by using a network of CO₂ -baited Mosquito Magnet Liberty Plus traps throughout Belgium in three key habitats(urban, agriculture and nature).



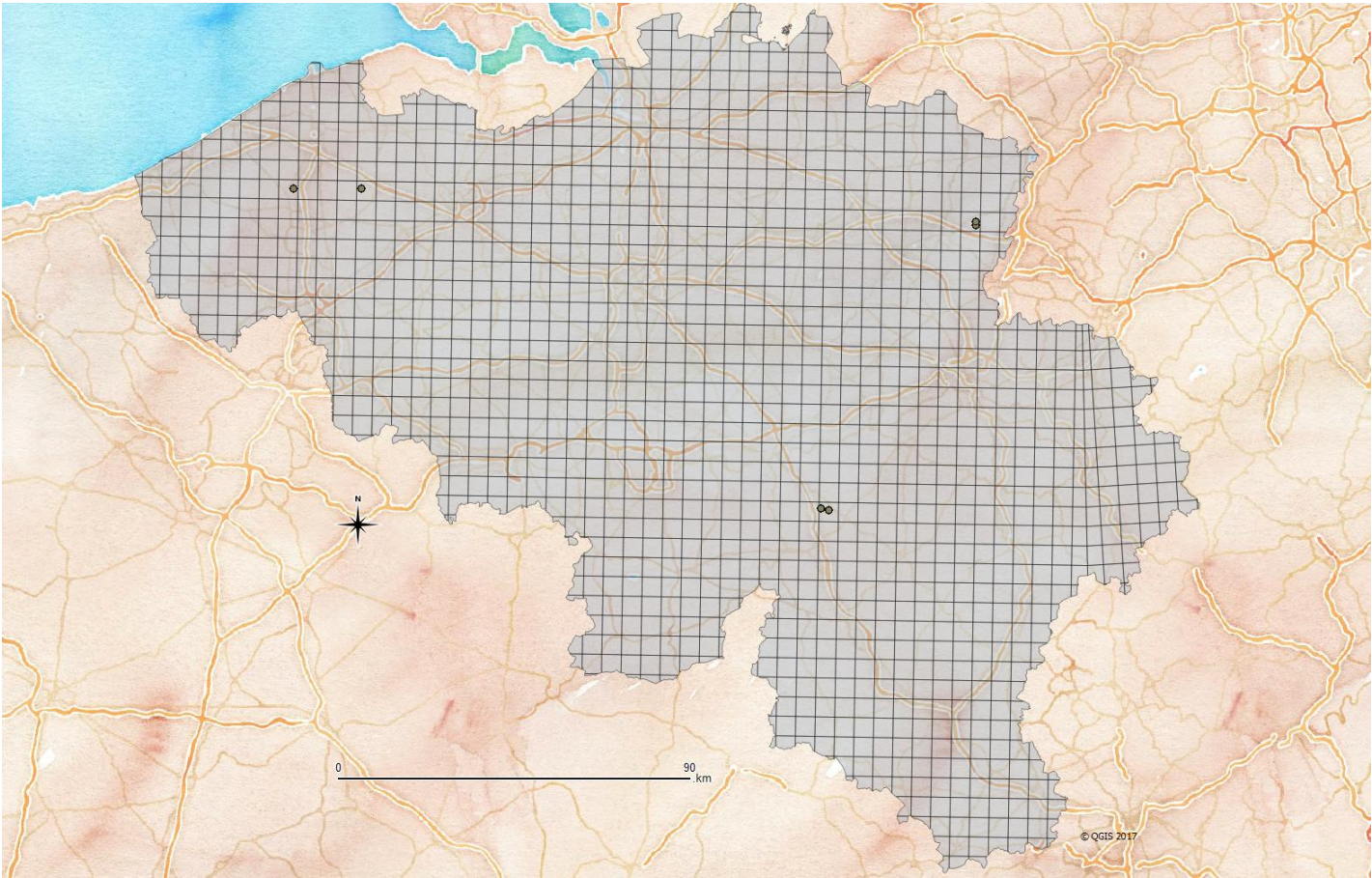
Inventory Occurrences



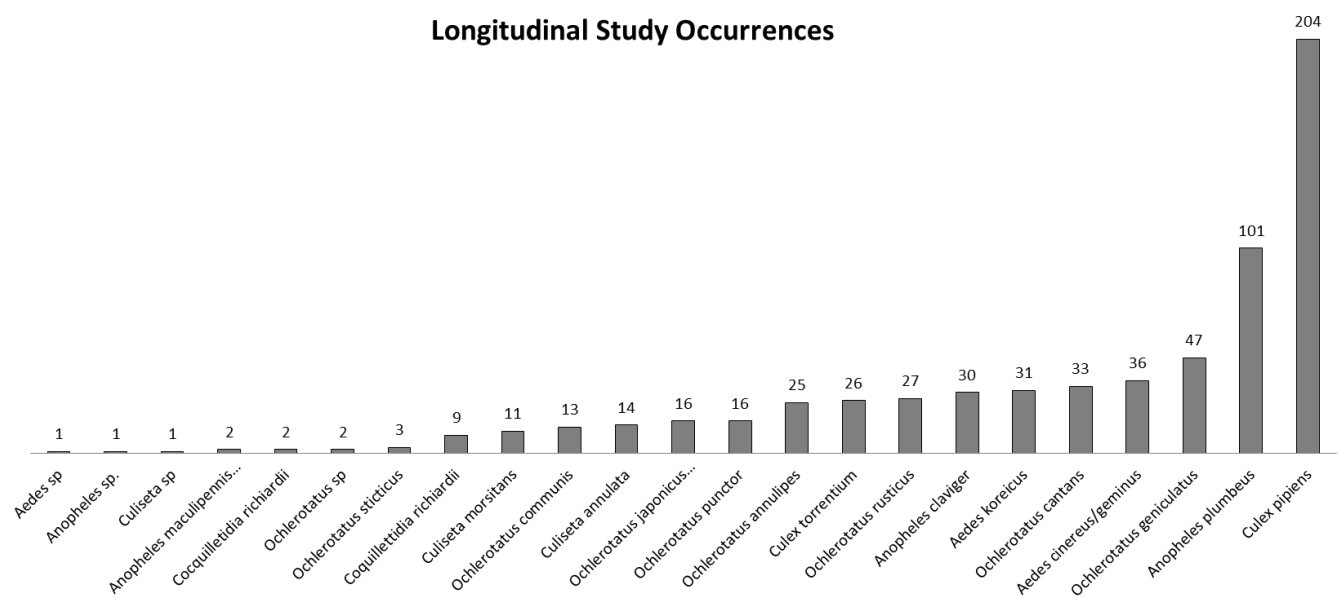
The Longitudinal dataset

The longitudinal studies were conducted on selected indigenous and exotic species found during the first phase of the project. In total 33682 adult mosquitoes were collected at the four sites with the twelve traps.

The Culicidae monitoring dataset (<http://www.gbif.org/dataset/9ee09033-8aab-4813-8c2b-db6d54d9817b>) dataset



Longitudinal Study Occurrences



Keywords

Occurrence, Voucher Specimens, Culicidae, vector disease, mosquito, malaria, Eco-climatic changes, taxonomy, spatial distribution models, population genetics, ecology of invasive species

Data published through

The occurrence datasets are available at:

MODIRISK: Monitoring of Mosquito Vectors of Disease (inventory) Source: <http://ipt.biodiversity.be/resource?r=modirisk-longitudinal-culicidae-study> GBIF: <http://www.gbif.org/dataset/6679952f-649b-4888-bd97-00daca4b8cc1>

MODIRISK:RBINS Diptera: Culicidae Collection Source: <http://ipt.biodiversity.be/resource?r=modirisk-rbins-culidae-collection> GBIF: <https://demo.gbif.org/dataset/3331bcd4-f85e-4252-8e92-3aaa6fdc3eca>

MODIRISK:Monitoring of Mosquito Vectors, Longitudinal study Source: <http://ipt.biodiversity.be/resource?r=modirisk-longitudinal-culicidae-study> GBIF: <https://demo.gbif.org/dataset/9ee09033-8aab-4813-8c2b-db6d54d9817b>

Collection

In the beginning of past century many mosquitoes were collected all over Belgium by dipterologists as M. Goetghebuer and M. Bequaert who both built up the most representative and rich collections of Belgian Diptera, preserved at RBINS (Grootaert et al., 1991). In the Belgian Culicidae collection of RBINS four subcollections are present: a general collection, two subcollections (Goetghebuer and Becquart), and a subcollection of unidentified specimens i.e. the supplements. The subcollection Bequaert was mainly collected between 1912-1958 and counts 135 voucher specimens. The subcollection Goetghebuer was collected between 1909-1946 (mainly between the period 1910-1930) and counts 269 specimens. In the general collection 241 specimens are present all of them collected between 1878-1967 (mainly between 1880-1925). The supplements are the largest subcollection with 737 specimens collected between 1892-2005 (mainly during 1920-1960).

All 1381 specimens (24 species) in RBINS collections were reidentified and digitised. Most of the specimens (77%) were collected between 1910 and 1960. Most specimens were collected between 1940 and 1950. The intensity of research and mosquito-sampling fluctuated during this period, as revealed by the number of voucher specimens per decade (Figure 8). The oldest specimens (collected in 1878) are deposit in the general collection. In this collection 16 species were discovered, in the subcollection Bequaert, the subcollection Goetghebuer and in the supplements respectively 18 species, 21 species and 20 species were counted. *Culex pipiens* and *Culiseta annulata* were the most abundant recorded species present in the collection. Also many voucher specimens of *Aedes punctor* were present.

Curatorial units

RBINS-Entomology Collection: M. Bequaert (135 voucher specimens - 1912-1958)

RBINS-Entomology Collection: M. Goetghebuer (269 voucher specimens - 1909-1946)

RBINS-Entomology Collection: Supplements Collection (737 specimens - 1892-2005)

RBINS-Entomology Collection: RBINS Insect Collection (241 specimens- 1878-1967)

Taxonomic coverage

Morphological identification of the Culicidae was done mainly using the electronic identification key of Schaffner et al. (2001) and the paper key of Becker et al. (2010). Data were stored into the web based database as described above.

Taxonomic ranks

Kingdom: *Animalia* **Class:** *Insecta*, **Orders:** *Diptera*, **Families:** *Culicidae*

Geographic coverage

Belgium is a small country in Western Europe. To the west, its 70 km coastline fronts the North Sea; to the north lies the Netherlands; to the east, Germany, and to the south, France and Luxembourg. Biogeographically, the fauna of eastern Belgium belongs to the Central European Province of the Eurasian (Palearctic) region. By contrast, the rest of the country primarily consists of an Atlantic fauna plus a few Central European relict species.

Politically and geographically, the country is divided into three parts: Flanders, Wallonia and the Brussels Capital Region (Figure 3). In Flanders (13, 522 km² and population about 6 million people), to the north, soils are mainly sandy to loamy. Here, the most important habitats for ants are heathlands and dry grasslands. The Brussels Capital Region is a small region (162 km²) entirely situated in the sandy loam area. In Wallonia (17, 006 km² and about 3, 5 million people), to the south, soils and habitats are more diverse, ranging from forests to rocky and calcareous grasslands on loam and chalky soils. Eastern Wallonia, near the German border, includes the Hautes Fagnes, a large area of bogs and peat with some typical ant species.

Belgian has a temperate maritime climate that is influenced by the North Sea and the Atlantic Ocean with substantial precipitation in all seasons. The summer is moderate and the winters are mild. The two main geographical regions of Flanders are the coastal plain in the North-West and the Central plain, further inland. With 470 inhabitants/km², Flanders is one of the most densely populated areas of Europe. The three major rivers are the River Yser, the River Scheldt, and the River Meuse. All rivers in Flanders flow into the North Sea, but only the River Yser drains directly into the sea within the jurisdiction of Flanders.

Geographical method

Geographical method is not provided in the IPT metadata as such.

The Universal Transverse Mercator Projection (UTM), an adaptation of the standard Mercator projection, uses a two dimensional Cartesian co-ordinate system to identify locations on the surface of the Earth (Wikipedia).

The UTM 5 Km (Universal Transverse Mercator Projection) raster projection divides Belgium in approximately 1200 25 km² squares (Figure 3). A representative number of UTM squares has been sampled (1125 UTM 5×5 km squares of which 659 squares with more than 10 records: see Figures 3 and 4) to complete the dataset. All the records in the Modirisk Collection Dataset are georeferenced through the centroid coordinates of the corresponding UTM 5 km square. Therefore, the uncertainty on these coordinates is 3.500 meters, the distance between the centre and the corner of the UTM square.

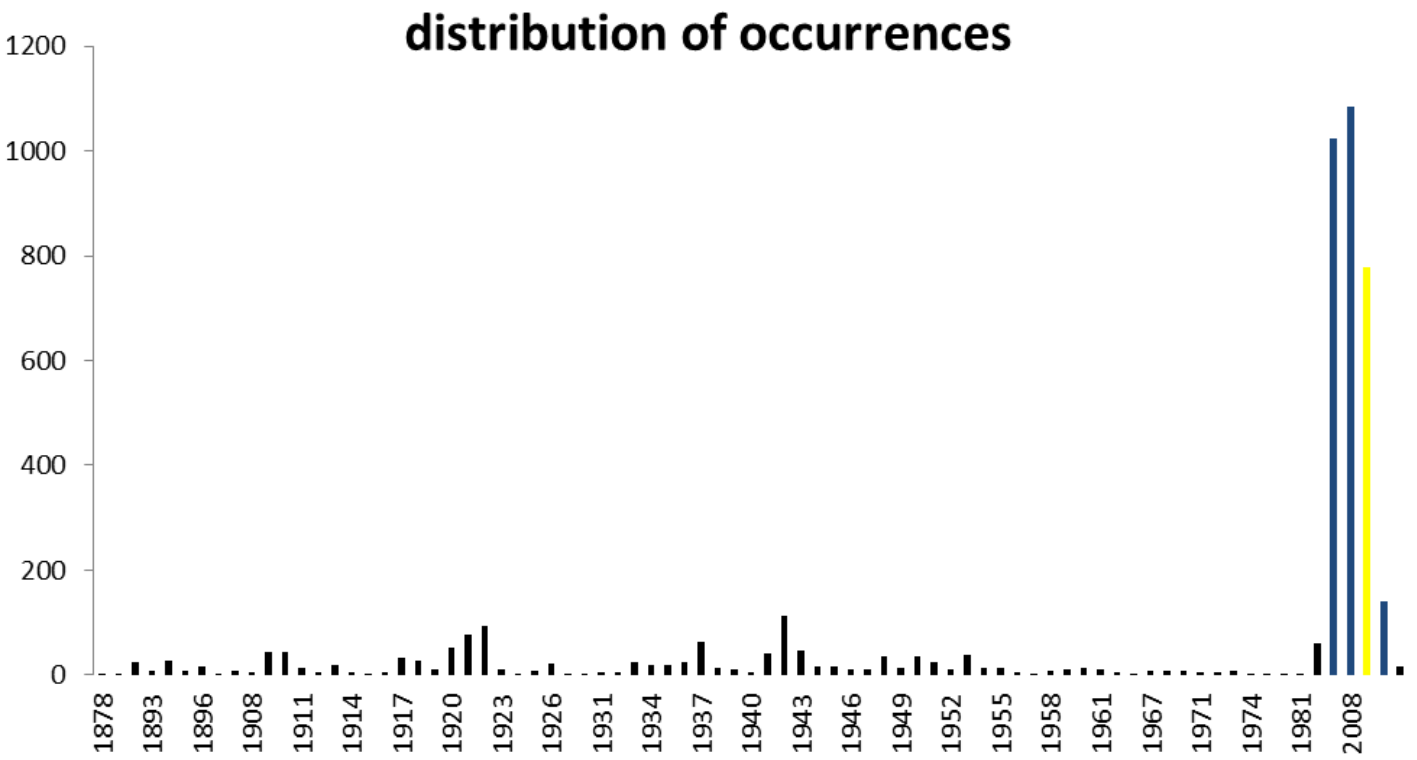
Bounding coordinates

IPT > Geographic coverage > Coordinates

50° to 51,51° latitude, 2.54 to 5.92 longitude.

Temporal coverage

The Collection dataset 1812-2005 The Inventory 2007-2008 The Longitudinal dataset 2009-2010



Dataset

Dataset description

Technical description of how the dataset was built. Does not appear in the IPT metadata.

The occurrence data from the MODIRISK database are extracted, standardized, and published as three separate Darwin Core Archives: The Collection, the Inventory and the longitudinal study. The main rationale behind this is that these different datasets are built for their own specific purpose and differ in sampling protocols and methods. Together these datasets represent a complete overview of the data collected during the Modirisk project.

The data are standardized to Darwin Core with **CHECK**

The Darwin Core terms (<http://rs.tdwg.org/dwc/terms/>) in the dataset at the time of publication are:

Inventory Dataset

Occurrence Core

id; type; license; institutionCode; basisOfRecord; dynamicProperties; occurrenceID;
individualCount; sex; samplingProtocol; eventDate; year; verbatimEventDate
habitat; continent; country; countryCode; stateProvince; municipality
locality; locationRemarks; decimalLatitude; decimalLongitude; geodeticDatum identifiedBy; scientificName; genus; specificEpithet

- **Object name:** Darwin Core Archive MODIRISK: Monitoring of Mosquito Vectors of Disease (inventory)
- **Character encoding:** UTF-8
- **Format name:** Darwin Core Archive format
- **Format version:** 1.0
- **Distribution:** <http://ipt.biodiversity.be/archive.do?r=modirisk-monitoring-2>
- **Publication date of data:** 2017-06-08
- **Language:** English
- **Licences of use:** Creative Commons Attribution (CC-BY) 4.0 License
- **Metadata language: English*
- **Date of metadata creation: 2013-11-28*
- **Hierarchy level: Dataset*

Collection Dataset

Occurrence Core

id; type; language; license; rightsHolder; accessRights; institutionCode collectionCode
datasetName; ownerInstitutionCode; basisOfRecord; occurrenceID catalogNumber; recordedBy; sex;
lifeStage; preparations; disposition; eventDate year; month; day; countryCode; stateProvince municipality; locality
verbatimCoordinates; verbatimLatitude; verbatimLongitude; decimalLatitude
decimalLongitude; geodeticDatum; georeferenceRemarks; identifiedBy; scientificName
originalNameUsage kingdom; genus; specificEpithet; nomenclaturalCode

- **Object name:** Darwin Core Archive MODIRISK:RBINS Diptera: Culidae Collection
- **Character encoding:** UTF-8
- **Format name:** Darwin Core Archive format
- **Format version:** 1.0
- **Distribution:** <http://ipt.biodiversity.be/archive.do?r=modirisk-rbins-culidae-collection>
- **Publication date of data:** 2017-02-20
- **Language:** English
- **Licences of use:** Creative Commons Attribution Non Commercial (CC-BY-NC) 4.0 License
- **Metadata language:** English
- **Date of metadata creation:** 2017-02-15
- **Hierarchy level:** Dataset

Longitudinal study

Event Core

id; type; language; license; rightsHolder; accessRights; datasetID

institutionCode; datasetName; ownerInstitutionCode; eventID; parentEventID
samplingProtocol; eventDate; year; month; day; verbatimEventDate; eventRemarks
countryCode; municipality; locality; verbatimLatitude; verbatimLongitude decimalLatitude; decimalLongitude; geodeticDatum

Occurrence Extension

id; type language; license; rightsHolder; accessRights; institutionCode
datasetName; ownerInstitutionCode; basisOfRecord; occurrenceID; individualCount
eventID; parentEventID; samplingProtocol; eventDate; verbatimEventDate; eventRemarks
countryCode; municipality; locality; verbatimLatitude; verbatimLongitude
decimalLatitude; decimalLongitude; geodeticDatum; scientificName; kingdom; genus specificEpithet; nomenclaturalCode

- **Object name:** Darwin Core Archive MODIRISK:Monitoring of Mosquito Vectors, Longitudinal study
- **Character encoding:** UTF-8
- **Format name:** Darwin Core Archive format
- **Format version:** 1.0
- **Distribution:** <http://ipt.biodiversity.be/archive.do?r=modirisk-longitudinal-culicidae-study>
- **Publication date of data:** 2017-02-22
- **Language:** English
- **Licences of use:** Creative Commons Attribution Non Commercial (CC-BY-NC) 4.0 License
- **Metadata language:** English
- **Date of metadata creation:** 2017-02-17
- **Hierarchy level:** Dataset

The data are published under a Creative Commons CC-BY-NC license and we ask you to notify the corresponding authors of the respective dataset if you use the data, especially for research purposes.

Additional information

This datapaper is linked with 3 Modirisk mosquito related datasets. The Longitudinal study, the Inventory and the collection dataset. The database server uses Windows Server 2003 SBS R2 as operating system, and is running IIS with PHP for site development, MS SQL Server for database development and SQL Server Mobile Tools to allow remote access from a PDA. Three types of MODIRISK forms were prepared by the MODIRISK coordinator and adapted during a group session at Project SD/BD/04 - Mosquito vectors of disease: spatial biodiversity, drivers of change, and risk "MODIRISK" SSD-Science for a Sustainable Development - Biodiversity 19 ITM: (1) Field form, (2) Morphological identification form, (3) Mosquito storage form. Based on these, relevant tables (Figure 5) were developed by Avia-GIS, implemented in the database, and transferred to the web server.

Usage norms

Give credit where credit is due

As is common practice in scientific research, cite the sources you are using. Researchers, volunteers, and personnel have invested a lot of time and effort in creating and publishing the biodiversity information you are using, and they deserve credit for their work. For scholarly publications, follow the citation practices that apply or the [GBIF best practices on data citation](#). In any other context, include at least a link to the original dataset if technically feasible.

Be responsible

Use the data responsibly. The data are published to allow anyone to better study and understand the world around us, so do not use the data in any way that is unlawful, harmful, or misleading. Understand that the datasets are subject to change, errors, and sampling bias. Read the metadata to better understand the scope and original intent of the dataset.

Respect the data waiver

To help you, we try to publish all our data with a creative commons license. Please respect this CC-BY license, and give credit when you reuse this dataset. Do not provide false or misleading information about the open status of the data.

Get in touch

Get in touch! We are always interested to know how you have used or visualized the data, or to provide additional information and data. It

helps both of us reach a wider audience and could be the start of a great collaboration. Our contact information can be found in the metadata.

Discussion optional

Discussion of the dataset. Does not appear in the IPT metadata. A discussion is optional in a data paper.

History of the dataset optional

History of the dataset does not appear in the IPT metadata. The history of the dataset section is optional in a data paper.

Dataset history

Methodology

Study extent description ### Sampling description

Collection RBINS & The Inventory

At the Royal Belgian Institute of Natural Sciences (RBINS) about 1400 mosquito-specimens from the Belgian collection of the Entomology Department were screened and if needed, added to the collection. All these and previous Belgian records were added to a newly established database **CULIBEL**.

Both RBINS and MODIRISK collections were used to compare recent and old data distributions (UTM 10x10km squares). A trend criterion was made of well surveyed grid cells and a decline of diversity near larger cities could be observed. An increase of distribution area was observed for several potential mosquito vectors having the capacity to use artificial containers as breeding sites. For 23 species there is a relative change in distribution area in 56 (10x10km) grid cells. A molecular archive was constructed of all collected species based on the DNA barcoding region at the ITMA. Moreover, a larval molecular identification assay was developed to rapidly detect and identify possible invasive species.

Longitudinal study

Longitudinal studies were conducted in 3 selected sites across Belgium in the late summer of 2009 and the spring of 2010. The aim was to assess whether mosquito presence and abundance in the selected sites were correlated to those found in The Netherlands. It was assumed, though, that as the typical meadow landscapes as found in much of the North West of The Netherlands are not present in Belgium, differences in mosquito species composition and/or abundance might occur.

Study site Maasmechelen (MA)

The area surveyed was an old sand quarry near the national park Hoge Kempen and the industrial park of Maasmechelen, which harbours several recycling companies. One site was the initial reference site, a small mixed forest fragment with birch, oak and pine next to the industrial zone (MA1). The other subsite (MA2) was situated in the opposite of the road, in a narrow strip of mixed forest adjacent to a large nature reserve (heath). Land cover consists largely of mixed small forest, moorland, sand quarry and a large industrial zone.

Study site Natoye (NT) The population of *Aedes japonicus* at Natoye was surveyed by UCL. Two Belgian second-hand tire companies located in the village of Natoye (Namur) were surveyed. Sites were named Natoye1 (50.3389587° N, 5.044879° E) and Natoye2 (50.33588° N, 5.0714698° E). The companies import mainly tires for trucks and heavy vehicles originating from various countries (only from Europe). Tires are stacked outside and many are exposed to rainfall and contain water and organic material like decomposing leaves. Landcover consists largely of deciduous forests, gardens, cultivated fields around Natoye1 and gardens, cultivated field and meadows around Natoye 2.

Study Site Ruiselede (RL) & Study Site Torhout (TH) We sampled mosquitoes at two different localities in Western Flanders in the same ecoclimatic region, during one complete active season from May until October: - an urban-rural landscape was sampled: 2 sites at Torhout near Groenhove forest complex (TH01 and TH02) (Figure 24) - a natural landscape was sampled: 2 sites at Ruiselede, Vorte Bossen (RL01 and RL02)

The sites were sampled two consecutive days (12:00 am-12:00 am) during 13 visits every two weeks from 20th of April 2009 until 5th of October 2009 with three types of traps (see 3.2). Sampling description: Mosquitoes were sampled with CO2 traps used throughout the Modirisk project. Each site was sampled for one week continuously, once between August and October 2009, and once again between April and June 2010. In this way, spring and fall populations of mosquitoes were expected to be found. Samples taken to Wageningen for taxonomic identification using the key provided by Schaffner (Schaffner 1993). Members of the *An. maculipennis* complex were further identified to species using a PCR of the ITS2 region (Marinucci et al. 1999).

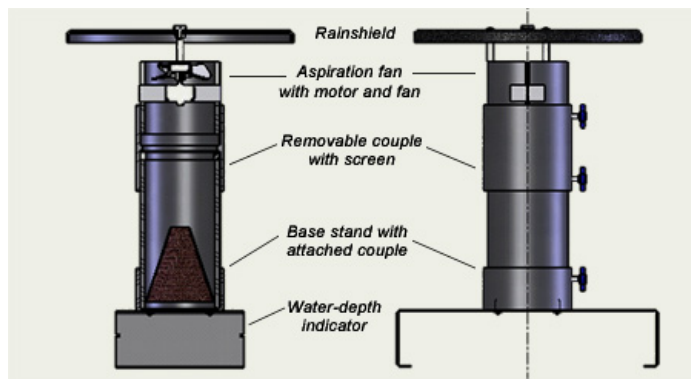
Each site or area was sampled thoroughly, with preferably each site/area consisting of different subsites. Each of this subsite was then again

sampled with a minimum of 6 traps (3 types, 2 of each type). The traps chosen are: the Mosquito Magnet Liberty Plus (MMLP), the BG Sentinel and Gravid trap (CDC, J. Hocke model). MMLP were used because of the fact that these traps were used during the inventory whilst BG Sentinels are often used to attract *Aedes* species and Gravid traps for *Culex* species. The sites were sampled fortnightly during 14 visits every two weeks from the 20th of April 2009 until the 12th of October 2009.

☐ Mosquito Magnet Liberty Plus



BG sentinel



Gravid Trap

Study Sites 1 Maasmechelen

The area surveyed was an old sand quarry near the national park Hoge Kempen and the industrial park of Maasmechelen, which harbours several recycling companies. One site was the initial reference site, a small mixed forest fragment with birch, oak and pine next to the industrial zone (MA1). The other subsite (MA2) was situated in the opposite of the road, in a narrow strip of mixed forest adjacent to a large nature reserve (heath). Land cover consists largely of mixed small forest, moorland, sand quarry and a large industrial zone.

Study site 2 Two Belgian second-hand tire companies located in the village of Natoye (Namur) were surveyed. Sites were named Natoye1 (50.3389587° N, 5.044879° E) and Natoye2 (50.33588° N, 5.0714698° E). The companies import mainly tires for trucks and heavy vehicles originating from various countries (only from Europe). Tires are stacked outside and many are exposed to rainfall and contain water and organic material like decomposing leaves. Landcover consists largely of deciduous forests, gardens, cultivated fields around Natoye1 and gardens, cultivated field and meadows around Natoye 2.

Study site 3 & 4

We sampled mosquitoes at two different localities in Western Flanders in the same ecoclimatic region, during one complete active season from May until October: - an urban-rural landscape was sampled: 2 sites at Torhout near Groenhove forest complex (TH01 and TH02) (Figure 24) - a natural landscape was sampled: 2 sites at Ruiselede, Vorte Bossen (RL01 and RL02)

Quality control description: Samples taken to Wageningen for taxonomic identification using the key provided by Schaffner (Schaffner 1993). Members of the *An. maculipennis* complex were further identified to species using a PCR of the ITS2 region (Marinucci et al. 1999).

Quality control description

[IPT](#) > [Sampling methods](#) > [Quality control](#)

Method step description

[IPT](#) > [Sampling methods](#) > [Step description](#): all steps

Project data

Project title: Mosquito vectors of disease: spatial biodiversity, drivers of change, and risk

Funding: Belspo, Science for Sustainable Development- Project SD/BD/04D (<http://www.belspo.be/belspo/ssd/science/prbiodiversityen.stm>) Study area descriptions/descriptor: Project fiche: http://www.belspo.be/belspo/ssd/science/projects/MODIRISK_en.pdf Project report:http://www.belspo.be/belspo/ssd/science/Reports/FinalReport_MODIRISK%20ML.pdf

- **Principal investigators:** Wouter Dekoninck; Wim van Bortel; Veerle Versteirt
- **Resource contact, resource creator, point of contact:** Wouter Dekoninck; Wim van Bortel; Veerle Versteirt
- **Metadata provider:** Dimitri Brosens
- **Content providers:** Wouter Dekoninck; Wim van Bortel; Veerle Versteirt
- **Processors:** Dimitri Brosens

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References

[IPT](#) > [Citations](#) > [Bibliography](#)

references cited within the metadata

Changes in Species Richness and Spatial Distribution of Mosquitoes (Diptera: Culicidae) Inferred From Museum Specimen Records and a Recent Inventory: A Case Study From Belgium Suggests Recent Expanded Distribution of Arbovirus and Malaria Vectors W. Dekoninck Journal of Medical Entomology(2013),50(2):237 <http://dx.doi.org/10.1603/ME12134>

De Koninck at al, 2014, Changes in Species Richness and Spatial Distribution of Mosquitoes (Diptera: Culicidae) Inferred From Museum Specimen Records and a Recent Inventory: A Case Study From Belgium Suggests Recent Expanded Distribution of Arbovirus and Malaria Vectors, J Med Entomol (2013) 50 (2): 237-243. <https://doi.org/10.1603/ME12134>

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references based on this dataset

references describing the dataset

