The project ProgRAMM: Monitoring and mapping of invasive fruit pest insects

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Abstract

The federal project ProgRAMM has the objective to update the pest risk analysis (PRA) of climate sensitive invasive pest insects in fruits and other cultures. Current models for the prognosis of the future distribution of invasive pest insects are based on climate data from 1960-1990. That means the weather extremes and climate change data 1990-2019 are not yet part of the analysis, i.e. the plant health risk of some pests might be underestimated. The project includes the federal Plant Health Institute of the Julius Kuehn-Institute (JKI) and programming specialists who are developing a free software for modelling the future distribution of new pest species. The Agricultural Research Center in Karlsruhe (LTZ) is providing monitoring and biological data of six selected species, including the occurrence of their natural enemies. Monitoring includes data from citizen science and social media as well as publications, trapping and visual observations. The observed species include the Brown marmorated stink bug Halyomorpha halys, Southern green stink bug Nezara viridula, European pear scale Epidiaspis leperii and the Mediterranean fruit fly Ceratitis capitata.

Keywords: climate sensitive species, invasive species, distribution models, plant health, citizen science

Introduction

Monitoring and mapping tools are basic features of biodiversity and faunistic studies, but may also be used in national monitoring programmes of plant health issues. In the German federal project “ProgRAMM“ these tools are being explored and used to optimize pest risk analysis data (PRAs) of potentially invasive pest species. The project is a cooperation between the Julius Kuehn-Institute (JKI), the Potsdam Institute for Climate Impact Research (PIK) and the Agricultural Research Center Augustenberg (LTZ) in Karlsruhe. The risk assessment of imported species is so far based on climate data from 1960-1990 and does not include the weather extremes and climate development of the recent years (LUBW 2019). On the other hand basic distribution data even for important pest insect species are often missing. They are needed for modelling the future spread of relevant pest species. To provide such a free modelling software for climate sensitive organisms is one part of the ProgRAMM-project (Heß et al. 2019).

The concept of the monitoring part of the project is to build a cooperation network between the different information sources on insect observations. The species to be observed are the Southern green stink bug *Nezara viridula*, the Brown marmorated stink bug *Halyomorpha halys*, the Mediterranean fruit fly *Ceratitis capitata* and the European pear scale *Epidiaspis leperii*. They represent different distribution patterns of climate sensitive pest species in fruit productions (Reißig & Zimmermann 2019).

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Material and Methods

Trapping as a traditional tool or beating samples in fruit production have to be expanded to effectively detect invasive species. Zero catches have to be documented and provide important information about pest free areas in the distribution modelling and according to their distribution speed. Visual monitoring is the key for assessing exact biological data of invasive species in their new environment, e.g. data on mating, oviposition, developmental stages, the number of generations and potential natural enemies. For *H. halys* and *C. capitata* specific pheromones are available. Other species need further investigation. *E. leperii* is hiding under green algae covering on branches. *N. viridula* has to be observed visually. The methods for data collecting vary for each of the selected insect species. Workshop training may be necessary since plant protection experts are usually not familiar with identifying the new species and their biology.

Data records on the distribution of insects are being collected from many sources (fig. 1), not only from classic literature research and insect experts or plant protection services. The internet, e.g. expert websites and citizen science social media apps (iNaturalist 2019) provide information that can be explored parallel to direct observations and improve the monitoring into a more focussed observation strategy. Once the most important data sources for one species or a species group has been found these data sets just have to be updated regularly.

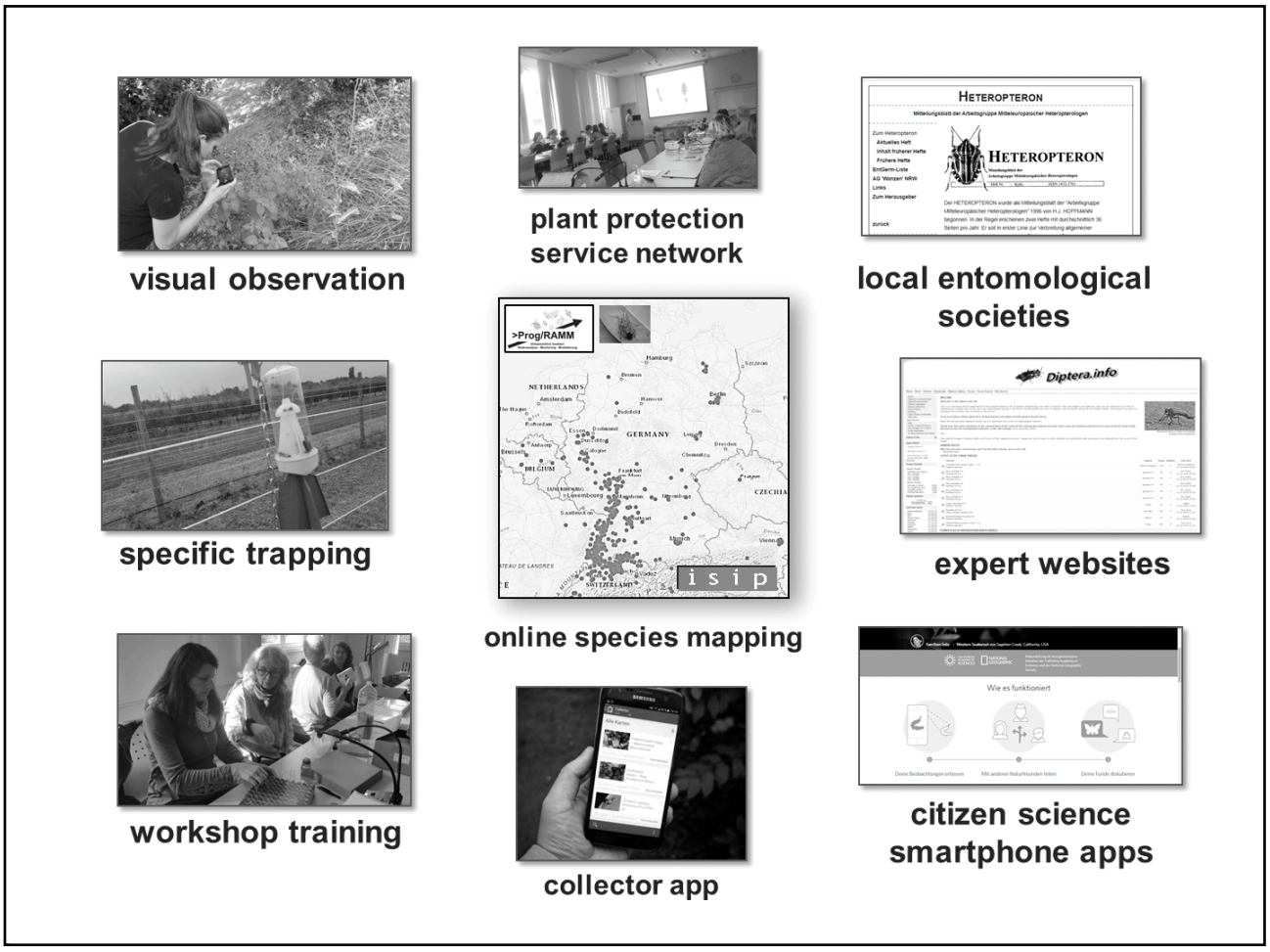

Figure 1: Multiple data sources are being focussed into one collector app and online mapping

In the ProgRAMM-project these monitoring data are being displayed using the internet mapping software ArcGIS-Portal by ISIP (ISIP 2019). Data collection is facilitated by an internet application (ArcGIS-Collector) and finally distribution maps can be displayed in realtime on any internet-website.

First results and conclusion

In this beginning phase of the project the data collection for climate sensitive species distribution showed different options and problems. On one hand data collected by non-experts seem to be quite reliable for easy to be identified and wide spread species, e.g. *H. halys* and *N. viridula*. On the other hand data on taxonomically difficult groups like scales insects, e.g. *E. leperii* are rare. But also visually eye-catching species like *C. capitata* are observed not very often by citizen science volunteers like on iNaturalist (Table. 1).

Table 1: Citizen science data of selected invasive fruit pest insects on iNaturalist (11/2019).

study area	species	no. observer	no. identifier	no. records
World	*Halyomorpha halys*	9.134	1.354	6.102
Europe	*Halyomorpha halys*	1.551	318	1.008
Germany	*Halyomorpha halys*	132	67	220
World	*Nezara viridula*	2.466	736	3.876
Europe	*Nezara viridula*	1.467	381	2.298
Germany	*Nezara viridula*	115	69	164
World	*Ceratitis capitata*	231	96	264
Europe	*Ceratitis capitata*	73	41	59
Germany	*Ceratitis capitata*	3	4	3
World	*Epidiaspis leperii*	0	0	0

Apart from other sources table 1 displays the basic problem of citizen science data. For the Brown marmorated stink bug *H. halys* there are six times more data on a worldwide scale available compared to Europe and even almost 30 times compared to German records. The number of records for *H. halys* including all sources in the ProgRAMM-project reaches up to 3.000 for Germany (11/2019). The Southern green stink bug *N. viridula* has about two times more records on a worldwide level, but still more than 20 times more than in Germany. For the Mediterranean fruit fly *C. capitata* there are just a few records in Germany. The European pear scale *E. leperii* does not even have any records on iNaturalist worldwide. This might display the distribution of the insects, but also the home of the insect experts and their interests. It will be a challenge trying to improve the records of the Pear scale on such a citizen science forum using guides and providing sample records. Using data for scientific work of course would also mean sharing data and becoming part of these citizen science communities.

Training volunteers and offering comprehensive guidelines should be a standard for future monitoring projects for implementing citizen science data. Plant protections experts are often only interested in positive records and entomologist usually only in their favorite insect group. Putting all these data resources together may offer the best practice to optimize the distribution mapping of species. Citizen science data might also be future mayor data resource for monitoring insects in larger areas with minimum expert resources like a native bee study in Australia (Mason & Arathi 2019). Still, such projects would need training and

guidelines. The first data of the ProgRAMM-project show the necessity to develop single data acquisition strategies for each climate sensitive monitoring species.

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