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Preventing HLB epidemics for ensuring citrus survival in Europe

[D6.1] Report about the Alarm Program and design of Citrus Health Management Areas (IVIA, ALG, FUND, M37)

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Work Package Title	DEVELOPMENT OF PSYLLID/HLB MANAGEMENT STRATEGIES				
Linked Task/s Title	Task 6.1. Development of an Alarm Program linked to a Three-Pronged System. Outline of Citrus Health Management Areas (CHMAs). Set size and location of CHMAs. Development of a kit for early diagnosis of CLs in psyllids and trees				
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Contents

1 EXECUTIVE SUMMARY

Huanglongbing (HLB) of citrus is associated with the bacteria '*Candidatus* Liberibacter asiaticus', '*Ca*. L. africanus' and '*Ca*. L. americanus'. These pathogens are transmitted by grafting and by the insect vectors *Diaphorina citri* and *Trioza erytreae*. HLB has not been described in the Mediterranean basin, but *T. erytreae* is present in the Iberian Peninsula and *D. citri* in Israel. HLB is considered the most destructive citrus disease worldwide and currently has no effective therapy. However, studies in the USA and Brazil indicate that it is possible to manage the disease by coordinated treatments against the vector through the establishment of regional management areas, Citrus Health Management Areas (CHMAs). Using spatial statistics, CHMAs have been developed for the main citrus growing areas of Spain, based on a risk map of 1 km^2 resolution. The risk estimation was carried out considering climatic information, as well as other variables that may influence vector development such as citrus density, transport routes, the presence of urban citrus and organic groves. A regionalization algorithm with size and risk homogeneity restrictions was implemented on this risk map to define the size and location of the CHMAs. The tool is open access and allows incorporating new risk estimates and modifying the size restrictions of the algorithm. The results will help growers manage potential HLB introductions and spread.

2 INTRODUCTION

Huanglongbing (HLB), or citrus greening, is considered the most citrus devastating diseased worldwide (Bové, 2006). HLB is caused by bacteria of the genus *Candidatus* Liberibacter and is primarily vectored by two insects of the Superfamily Psylloidea: the Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama (Hemiptera: Liviidae), and the African citrus psylla (AfCP), *Trioza erytreae* Del Gercio (Hemiptera: Triozidae).

The most prevalent type of HLB is associated with the bacterium Candidatus Liberibacter asiaticus (*Ca.* L. asiaticus), which is ustransmitted by grafting and mainly by the ACP (Bové, 2006). Both bacterium and vector have spread from Asia to the American continents and threaten citrus production in Brazil, Mexico, the United States and Argentina, which are among the top citrus producers worldwide (Garcia-Figuera et al., 2021).

Virtually, the vast majority of commercial citrus cultivars are susceptible to HLB (Ramadugu et al., 2016). Once a tree is infected, it becomes improductive within 5-10 years and it will tipically die (Bové, 2006; Bassanezi et al., 2013). At present, there are no commercial varieties nor rootstocks resistant or tolerant to HLB (Miles et al., 2017). Neither exists an economically viable or socially accepted curative remedy that completely eliminates the bacteria from the plant (Monzó and Stansly, 2020).

Based on the knowdlege of the HLB pathosystem of *Ca.* L. asiaticus and the ACP, the erradication of disease is difficult because the mobility and prolificacy of the vector. Furthermore, the bacterium multiplies in both the insect vector and the infected trees are infectious long before detection is possible (da Graça et al., 2016). Hence, effective action against this disease, whether it is present or not, can be achieved through efficient vector management (Monzó and Stansly, 2020).

Recent studies have demonstrated that productivity of infected trees can be maintained at sustainable levels, at least in the short-term, when specific agronomic measures are taken. Among them, preventing new bacterial re-inoculations through the suppression of infective vectors can drastically reduce the rapid decline of the tree and extent its productivity (Monzo and Stansly, 2017; Tansey et al., 2017).

Currently, vector management programs rely on frequent insecticide applications aimed to keep ACP numbers as close to zero as possible (Belasque Jr et al., 2010; Boina and Bloomquist, 2015; Alvarez et al., 2016). This approach can help to reduce the progression of vector populations, movement, and infection rates. However, the effective of the vector control requires area-wide management (AWM), which consists of time-coordinated insecticide sprays by all growers in a region organised in "Citrus Health Management Areas" (CHMAs) (Vreysen et al., 2007).

Establishment of CHMAs has been proposed as an important strategy for reducing the spread of HLB. The primary goal of the formation of CHMAs is to coordinate psyllid control efforts to reduce the effect of psyllid movement between commercial citrus operations and thus reduce the need for repeated back-to-back insecticides applications for maintaining psyllid populations at low levels. Due to the limited number of pesticide modes of action available for controlling psyllids, CHMAs could also serve an important function in slowing pesticide resistance development in psyllid populations by coordinating applications of pesticides with similar modes of action. Because coordinated treatments benefit the whole group, any grower may be tempted to rely on others' treatments and avoid the cost of spraying, but if a grower fails to coordinate, that property can sustain vector and spread HLB to the rest (Bassanezi et al., 2013).

The aim of this deliverable is to establish the boundaries of CHMAs within the main citrus growing regions within Spain

mainland contemplating the hypothetical HLB dispersal in the presence of *T. erytreae* as well as the possible future entrance of *D. citri*. For that purpose the methodology developed by Gottwald et al. (2014a,b) has been adapted.
CHMAs in Spain have been developed based on a risk map of 1 km^2 resolution. The risk characterization of the citrus growing regions was carried out considering climatic information, as well as other variables that may influence vector development such as citrus density, transport routes, the presence of urban citrus and organic groves. A regionalization algorithm with size and risk homogeneity restrictions was implemented on this risk map to define the boundaries of the CHMAs. The methodology that supports CHMAS construction was implemented in R language (R Core Team, 2021) and all the generic coded is available for the public following open science principles. This will allow the updating of this initial estimate as new knowledge becomes available and/or as the epidemiological situation changes. The results will help growers manage potential HLB introductions and spread.

3 MATERIAL AND METHODS

Climatic data

Climatic variables for Spain were obtained from the ERA5-Land dataset (Copernicus Climate Data Store) via the CDS user interface. ERA5-Land produces a total of 50 variables from 1950 to the present describing the water and energy cycles over land, globally, hourly, and at a gridded spatial resolution of 0.1° x 0.1°(∼ 9 km) (Muñoz Sabater et al., 2021). Hourly data were downloaded from ERA5-Land for the air temperature at 2 m (°K) and dew point temperature at 2 m (°K) from 2009-01-01 to 2018-12-31, and the projection was changed from UTM to ETRS89 LAEA. Dew point temperature was used to calculate relative humidity (RH) in % according to Wal (2006) as:

$$RH = 100 \cdot \left(\frac{e_s(Td)}{e_s(T)} \right) \tag{1}$$

with $e_s(Td)$ and $e_s(T)$ denoting actual vapor pressure and saturation vapor pressure in hPa, respectively; with Td as dew point temperature at 2 m and T as air temperature at 2 m both in ºC and for $e_s(Td) \leq e_s(T)$. Actual and saturation vapor pressure were estimated following Bolton (1980) as:

$$\begin{aligned} e_s(Td) &= 6.12 \cdot \exp[(17.67 \cdot Td/(243.5 + Td)] \\ e_s(T) &= 6.12 \cdot \exp[(17.67 \cdot T/(243.5 + T)] \end{aligned} \tag{2}$$

Daily maximum, minimum, mean temperature and minimum relative humidity were computed from the hourly variables using the R function '`apply.daily()`' from the R package `rts` (Babak, 2019).

Study area

The study area was set considering the suitable Spanish citrus-growing regions defined by the isotherm. The isotherm was defined as those areas where the minimum temperature values were higher than the citrus trees minimum development temperature (T_{min}> -4ºC). The temperature was set as a random intermediate value between the minimum temperatures threshold cited by Davies and Albrigo (1999) and De Villiers and Joubert (2006). For that purpose, the minimum temperature of January over the ten-year period climatic database was considered, and those areas with a minimum temperature above -4ºC were considered as suitable for citrus growing. All areas where the temperature was below the isotherm were discarded.
Georeferenced data from the citrus orchards of the suitable citrus growing regions of Spain defined by the isotherm were provided by the Spanish Government's Plant Health Authority ("*Ministerio de Agricultura, Pesca y Alimentación*"). The database of citrus orchard boundaries was extracted from the Agricultural Plot Geographic Information System (SIGPAC). It contained the orchard localization by UTM coordinates and additional information such as: orchard numeric identifier, surface, slope, irrigation coefficient, municipality, province (NUTS2), polygon identifier and crop category classification ('*uso_sigpac*') (MAPA, 2020a). The citrus orchards were filtered for the suitable areas within Spain mainland.

Commercial, organic and abandoned citrus orchards

To characteise citrus orchards in agricultural landscapes according to their management system, conventional vs. organic, and also in terms of their phytosanitary status, healthy (i.e., conventional and organic) and abandoned, two national databases (MAPA, 2019, 2020b) were considered. Based on the organic and abandoned surfaces specified at autonomous community level (NUTS2) in MAPA (2019, 2020b), abandoned and organic orchards were inferred randomly among the agricultural citrus orchards database at autonomous community (NUTS2) and province (NUT3) level.
Afterwards, the citrus-orchard database was aggregated in the referece LAEA grid 1 km^2 x 1 km^2 (EUROSTAT, 2019; Peifer, 2011) of the European Environmental Agency (EEA) to be managed in CHMAs contruction process. This referenced grid was downloaded from the statistical office of the European Communities (EUROSTAT, 2019) and it based on

the ETRS89 Lambert Azimuthal Equal Area coordinate reference system (EPSG code: 3035). LAEA grid has a coding system with unique identifiers for each cell.

Urban citrus

To estimate the urban citrus coverage, census population data and isotherm information were combined. Sepecifically, the Spanish census database aggregated at 1km ^{2} grid were extracted from GEOSTAT (2011) and subsequently intersected by the isotherm. The result of this intersection was projected into the reference LAEA grid where citrus orchards under agricultural landscape were aggregated in order to subset those cells that were suitable for citrus growing and also contained citrus orchards under agricultural management.
To infer urban citrus coverage from population census data information of urban citrus densities and population were extracted from Seville (Cabanillas, 2020; INE), 2020). Seville city was selected because it has the most significant citrus urban registry of Spain. Urban citrus data was estimated as:

$$\text{Urban citrus data} = \left(\frac{\text{Seville}_{\text{urban citrus data}} \cdot 20\frac{m^2}{tree}}{Seville_{\frac{inhabitants}{km^2}} \cdot \frac{10m^2}{km^2}} \right) = 1.330643 \cdot 10^6 \frac{trees}{inhabitants} \quad (3)$$

This conversion factor ($1.330643 \cdot 10^6 \frac{trees}{inhabitants}$) was multiplied by the previously extracted Spanish census data determined by the isotherm and aggregated to citrus orchards grid.

Transportation corridors

Transport routes for Spain were obtained from the Spanish National Geographic Institute via the Download Center (CNIG, 2021). Specifically, we downloaded the '*RT_Espana_PorModos.zip*' dataset, and from them, we used the '*RT_VIARIA_CARRETERA*' file, which only contains roads data, not sea or air routes. Subsequently, we filtered the road type (claseD in the file) to use only the Highways ("Autovía", "Autopista" in Spanish), discarding the others roads types.

Citrus Health Management Areas (CHMAs)

With the aim of defining the size and location of the Citrus Health Management Areas (CHMAs) a risk map within the study area was estimated on the basis of the 1 km^2 gridded map used to characterise commercial and urban citrus landscape in mainland Spain. The overall risk associated with each grid cell was determined as the sum of a set of risk factors. These major components of the risk were selected as being potentially influential in the invasion/spread processes of *D. citri* and *T. erytreae*, respectively, in line with previous studies (Gottwald et al., 2014b,a; Díaz-Padilla et al., 2014). Specifically, risk factor selected were related to the area covered by commercial citrus, proximity to abandoned, organic citrus groves, proximity to urban citrus, proximity to transportation corridors and climatic suitability conditions for vector potential development. With the exception of risk components associated with climatic suitability, which were calculated indepedently for *D. citri* and *T. erytreae* according to their biology and life cycle, the rest of risk components were estimated identically for both vectors. Risk estimation was addressed at autonomous community level(NUTS3). For more details on how the risk factors were selected and quantified, please see the **Supplementary Material.**

Commercial citrus area

The risk associated with commercial citrus area ($R_{com,i}$) was calculated according to:

$$R_{com,i} = \frac{CCA_i}{max(CCA_i)} \quad (4)$$

where CCA_i denotes the area (%) covered by commercial citrus (CCA) for each cell i.

Abandoned groves

The risk associated with the proximity of abandoned groves ($R_{abn,i}$) was calculated considering the presence of abandoned groves within a cell i and/or the proximity of cells with abandoned groves. The proximity criterion between cells was established considering a maximum distance between centroid cells $d_{i,j} \leq 1{,}500$ m. The baseline risk associated $R0_{abn,i}$ with each cell was computed as:

$$R0_{abn,i} = \begin{cases} CCA_i & \text{if } ACA_i = 0 \\ CCA_i \cdot F_{abn} & \text{if } ACA_i \neq 0 \end{cases} \quad (5)$$

where CCA_i and ACA_i denote the area (%) covered by commercial citrus and abandoned citrus for each cell i, respectively. $F_{abd} = 38$ based on the study of Martini et al. (2016) in which the mean number of *D. citri* adults were counted in several groves under different management practices (i.e., conventional, organic and abandoned). Average values of number of adults were 0.50 and 19 for conventional and abandoned, respectively, thus, $F_{abd} = 38 = 19/0.50$.

The $R_{abn,i}$ for each cell i was calculated as:

$$R_{abn,i} = \frac{R0_{abn,i} + \sum_{j=1}^{max=8} R0_{abn,j}}{max(R_{abn,i})} \quad (6)$$

where cell i and each cell j are considered neighbours if the distance between their centroids does not exceed 1,500 m. Thus, the maximum number of neighbours cells j per cell i was 8.

Organic groves

The risk associated with the proximity of organic groves ($R_{org,i}$) for each cell i was addressed similarly to the calculus of $R_{abn,i}$ considering the presence of organic groves within a cell i and/or the proximity of cells with organic groves. The proximity criterion between cells was also established considering a maximum distance between centroid cells $d_{i,j} \leq$ 1,500 m. The baseline risk associated $R0_{org,i}$ with each cell was computed as:

$$R0_{org,i} = \begin{cases} CCA_i & \text{if } OCA_i = 0 \\ CCA_i \cdot F_{org} & \text{if } OCA_i \neq 0 \end{cases} \quad (7)$$

where CCA_i and OCA_i denote the area (%) covered by commercial citrus and organic citrus for each cell i, respectively. $F_{org} = 6$ based on the study of Martini et al. (2016) in which the mean number of *D. citri* adults counted in a conventional and an organic orchard were 0.50 and 3, respectively. Thus, $F_{org} = 6 = 3/0.50$.
The $R_{org,i}$ for each cell i was calculated as:

$$R_{org,i} = \frac{R0_{org,i} + \sum_{j=1}^{max=8} R0_{org,j}}{max(R_{org,i})} \quad (8)$$

where cell i and each cell j are considered neighbours if the distance between their centroids does not exceed 1,500 m. Thus, the maximum number of neighbours cells j per cell i was 8.

Urban citrus

The risk associated with the proximity of urban ($R_{urb,i}$) for each cell i was addressed similarly to the calculus of $R_{org,i}$ considering the presence of urban citrus within a cell i and/or the proximity of cells with urban citrus. The proximity criterion between cells was also established considering a maximum distance between centroid cells $d_{i,j} \leq 1{,}500$ m. The baseline risk associated $R0_{urb,i}$ with each cell was computed as:

$$R0_{urb,i} = \begin{cases} CCA_i & \text{if } UCA_i = 0 \\ CCA_i \cdot F_{urb} & \text{if } UCA_i \neq 0 \end{cases} \quad (9)$$

where CCA_i and UCA_i denote the area (%) covered by commercial citrus and urban citrus for each cell i, respectively. Due to the lack of information, $F_{urb} = 6$ assuming that the presence/proximity of organic groves would affect similarly to *D. citri* and *T. erytreae* potential development that the presence/proximity to organic groves.
The $R_{urb,i}$ for each cell i was calculated as:

$$R_{urb,i} = \frac{R0_{urb,i} + \sum_{j=1}^{max=8} R0_{urb,j}}{max(R_{urb,i})} \quad (10)$$

where cell i and each cell j are considered neighbours if the distance between their centroids does not exceed 1,500 m. Thus, the maximum number of neighbours cells j per cell i was 8.

Transportation corridors

The highways used for commercial citrus production movement were considered the transportation corridors. The risk associated with the proximity of transportation corridors ($R_{tra,i}$) for each cell i was addressed considering the crossing of this type of roads within a cell i and/or their close proximity to other cells j which were also crossed. The proximity criterion between cells was also established considering a maximum distance between centroid cells $d_{i,j} \leq 1{,}500$ m. The baseline risk associated $R0_{tra,i}$ with each cell was computed as:

$$R0_{tra,i} = \begin{cases} CCA_i & \text{if } I_{tra,i} = 0 \\ CCA_i \cdot F_{tra} & \text{if } I_{tra,i} \neq 0 \end{cases} \quad (11)$$

where CCA_i denotes the area (%) covered by commercial citrus and $I_{tra,i}$ is an indicator variable which was set equal to 1, $I_{tra,i} = 1$, if the cell i was crossed by a transportation corridor. Due to the lack of information $F_{tra} = 6$ assuming that the crossing/proximity to the transportation corridors would affect similarly to *D. citri* and *T. erytreae* potential development that the presence/proximity to organic groves.

The $R_{tra,i}$ for each cell i was calculated as:

$$R_{tra,i} = \frac{R0_{tra,i} + \sum_{j=1}^{max=8} R0_{tra,j}}{max(R_{tra,i})} \quad (12)$$

where cell i and each cell j are considered neighbours if the distance between their centroids does not exceed 1,500 m. Thus, the maximum number of neighbours cells j per cell i was 8.

Climatic suitability

The risk associated with the climatic suitability was calculated separately for *D. citri* and *T. erytreae*. Specifically, for both vectors two risk components related to the number of potential generations (R_{npg}) and the number of days with favorable conditions (R_{ndfc}) were considered. For both risk factors estimates daily climatic data for the period 2009-2018, specifically daily maximum, minimum, mean temperature and minimum relative humidity, were used.

The $R_{npg,i}$ for each cell i calculus was based in estimating the average value of the cumulative degree-days for the 10-year period 2009-2018 and comparing it to the degree-days (DD) required for an egg of *D. citri* / *T. erytreae* to become an adult under a developmental threshold temperature (T_{base}) as follows:

$$R_{npg,i} = \frac{\frac{[(\sum T_{mean_{day_j,year_k},i}) - (T_{base} \cdot n_{days})]}{n_{years}}}{DD} \quad (13)$$

where $T_{mean_{day_j,year_k},i}$ denotes the daily mean temperature for the day j of the year k within the cell i with $j = 1, 2, ..., 365$ and $k = 1, 2, ..., 10$; and n_{days} and n_{years} denote the total number days and years of the period considered.

For *D. citri*, $T_{base} = 10.45°C$ and $DD = 249.88°C$ was set considering the previous values according to (Liu and Tsai, 2000). For *T. erytreae*, $T_{base} = 20°C$ and $DD = 302.58°C$.

The R_{ndfc} calculus was based in defining a favourable day for development in any of its stages (i.e., from egg to adult) based on dailiy minimum and maximum temperatures, for *D. citri* and based on daily maximum temperature and minimun relative humidity, for *T. erytreae*. According to the study of Liu and Tsai (2000) a favourable day (FD) for *D. citri* was defined as:

$$FD = \begin{cases} 1 & \text{if } T_{min} > 10°C \text{ and } T_{max} < 33°C \\ 0 & \text{, otherwise.} \end{cases} \quad (14)$$

For *T. erytreae* a favourable day (FD) for was defined as:

$$FD = \begin{cases} 0 & \text{if } RH_{min} < 25\% \text{ and } T_{max} > 30°C \\ 1 & \text{, otherwise.} \end{cases} \quad (15)$$

Thus, the $R_{ndfc,i}$ for each cell i was computed as:

$$R_{ndfc,i} = \frac{\sum FD_{day_j,year_k}}{n_{year}} \quad (16)$$

where $FD_{day_j,year_k}$ is an indicator variable of a favourable day for the day j of the year k within the cell i with $j = 1, 2, ..., 365$ and $k = 1, 2, ..., 10$ and n_{year} denotes the total number of years of the period considered (i.e. 10 years). Then, the risk $R_{ndfc,i}$ for each cell i was rescaling dividing by the maximum value estimated.

Overall risk map

The overall risk related to the potential invasion/spread of *D. citri* and *T. erytreae*, respectively, was estimated on the basis of the LAEA 1 km^2 gridded map of urban and commercial citrus within the Spanish mainland at autonomous community level (NUTS2) . As a first proposal each of these components of risk wre simply given equal weighting to estimate overall risk, because it was difficult to quantify the relative influence of each one of the, compared to the others without substantial data.

Regionalization algorithm

A constrained hierarchical clustering algorithm was considered to set CHMAs boundaries at autonomous community level(NUTS2) with a default spatial contraint at comarca level. This algorithm optimizes the convex combination $D_\alpha = (1-\alpha)D_0 + \alpha D_1$ of this criterion calculated with two dissimilarity matrices, D_0 and D_1 beyond a mixing parameter

$\alpha \in [0,1]$. The first dissimilarity matrix $D_0 = [d_{0,ij}]$ was constructed from the Euclidean distance matrix between the LAEA 1 km^2 citrus grid cells within a comarca performed with the overall risk variable ($j = 1$), i.e., the matrix gives the differences in the feature space, and the dissimilarity matrix $D_1 = [d_{1,ij}]$ was constructed from the geographical distance between these grid cells, i.e., the matrix D_1 gives the differences in constraint space. The minimized criterion at each stage is a convex combination of the homogeneity criterion calculated with D_0 and the homogeneity criterion calculated with D_1. The parameter α (the weight of this convex combination) gives the relative importance of D_0 as compared to D_1. This parameter controls the weight of the constraint on the quality of the solutions, i.e., for a given value of $\alpha \in [0,1]$, the mixing parameter α clearly controls the part of pseudo-inertia due to D_0 and D_1.

The R package `ClustGeo` developed by Chavent et al. (2018) was used to implement the regionalisation algorithm. To determine a suitable value for the mixing parameter α a sensitivity analysis was performed around different values and finally α was set at 0.9.

4 RESULTS

4.1 Citrus regions within Spain mainland

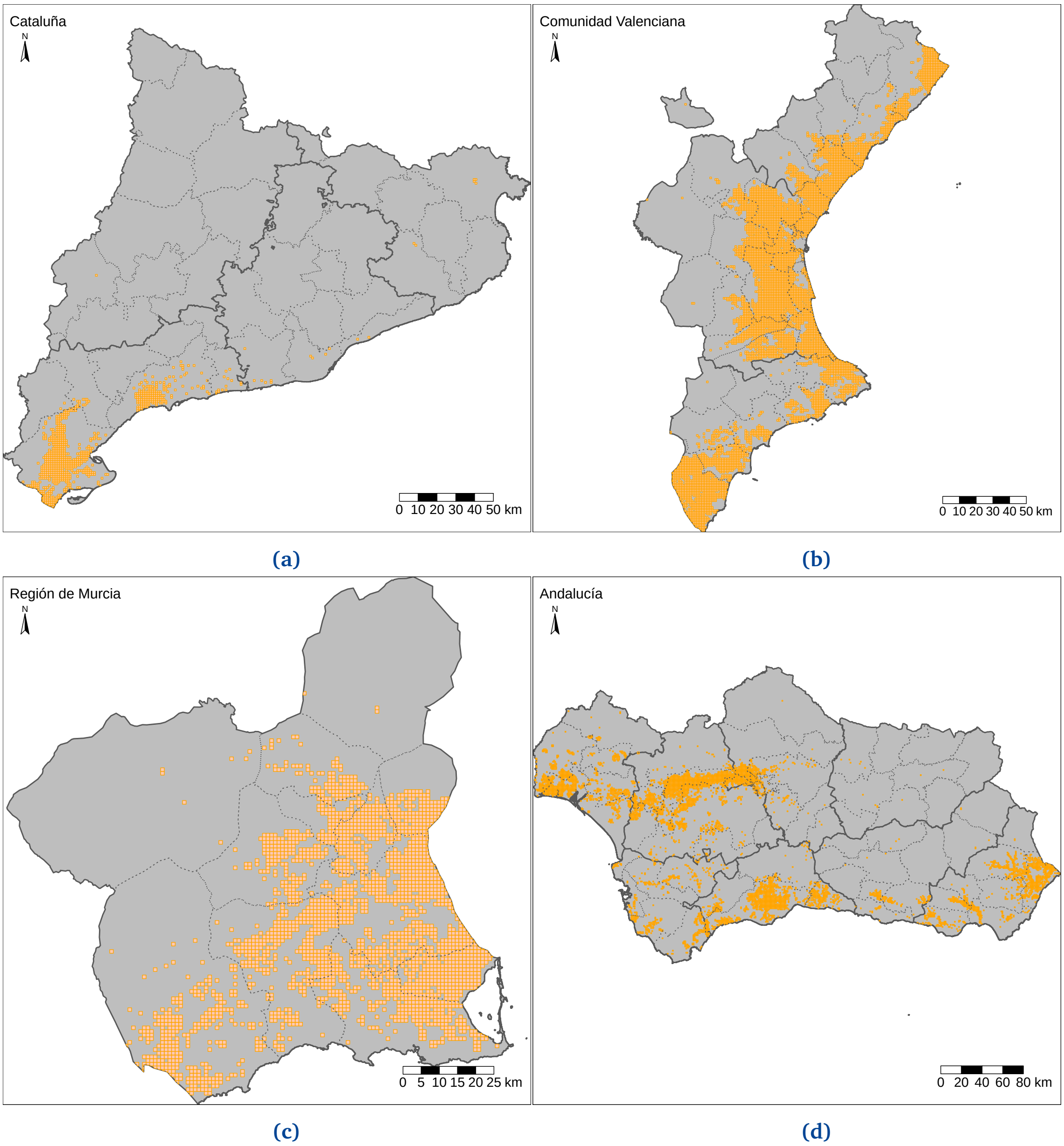

Figure 1. Citrus regions within Spain mainland at autonomous community level (NUT2).

Table 1. Numerical description of Citrus regions within Spain mainland at autonomous community level (NUT2).

Region	Commercial area (km^2)	Residential area (km^2)	Total citrus area (km^2)	Citrus grid size
Cataluña	84.593	0.198	84.791	834
Comunidad Valenciana	1710.089	2.946	1713.036	7021
Región de Murcia	300.822	0.597	301.419	2491
Andalucía	850.303	1.517	851.820	6683

4.2 Risk maps and CHMAs for Cataluña

Risk maps for Tarragona province

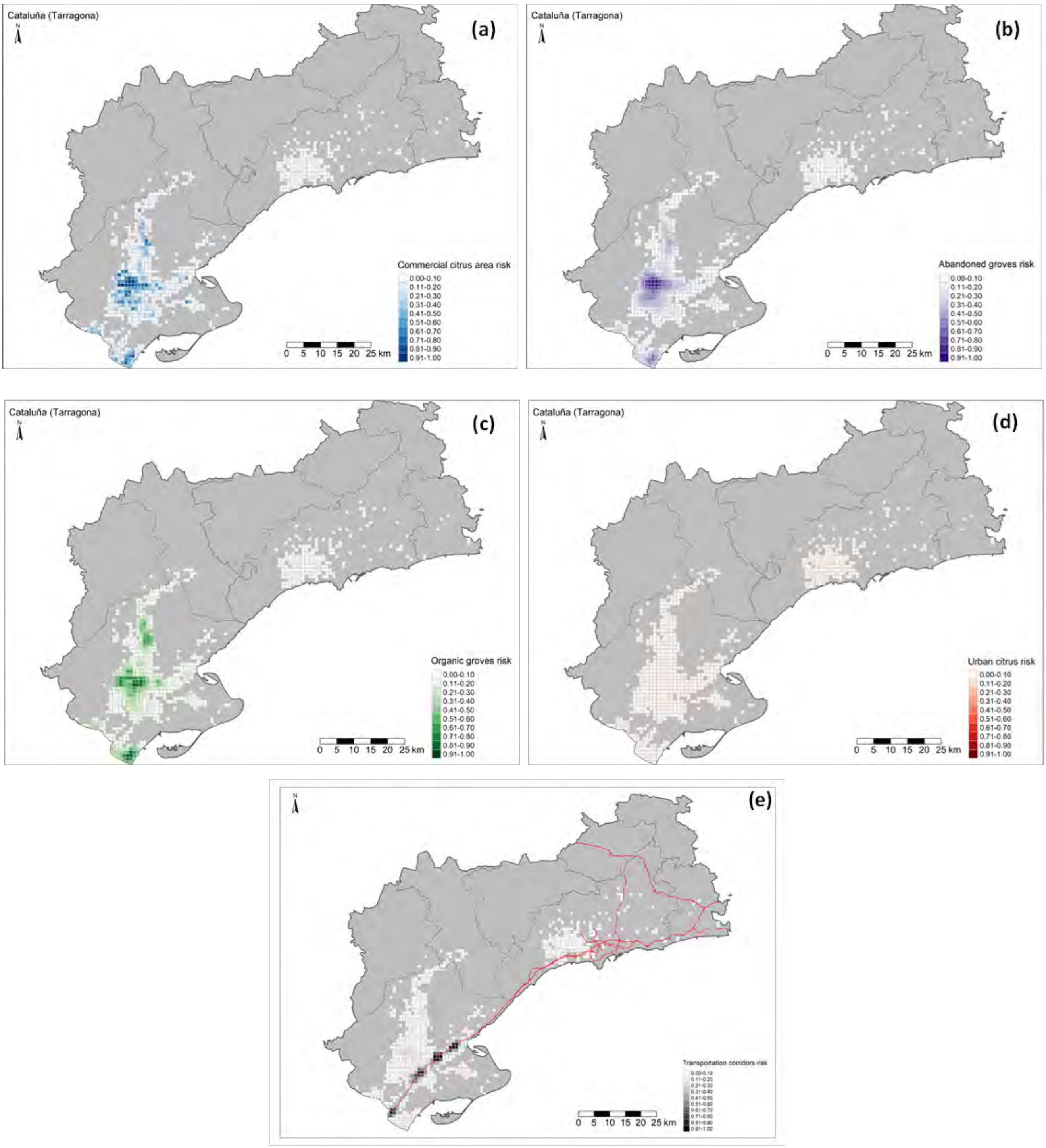

Figure 2. Risk maps for Tarragona province within the Cataluña autonomous community.

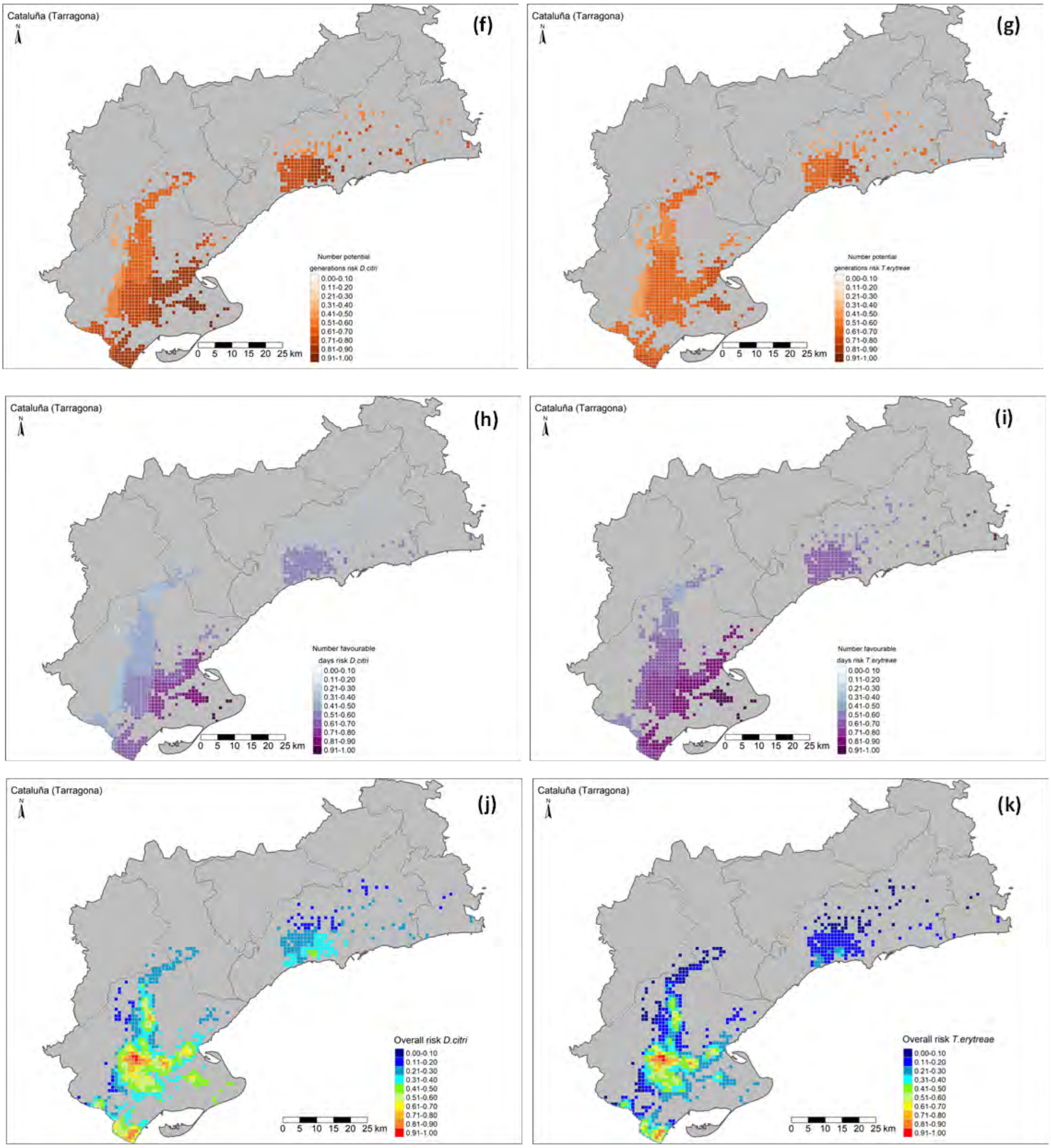

Figure 2. Risk maps for Tarragona province within the Cataluña autonomous community.

CHMAs for Tarragona province: graphical and numerical description

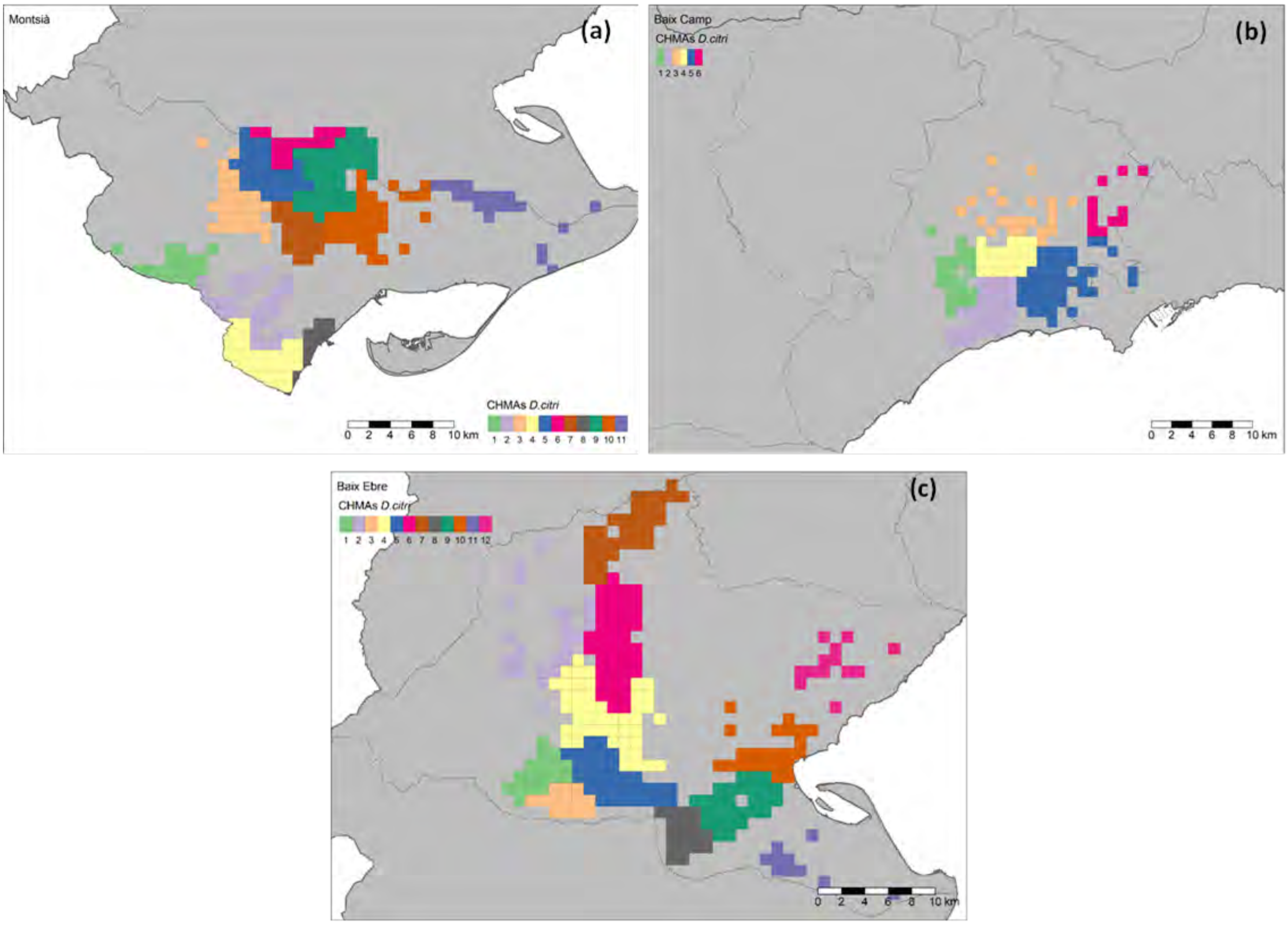

Figure 3. CHMAs for *D. citri* within Tarragona province at comarca level.

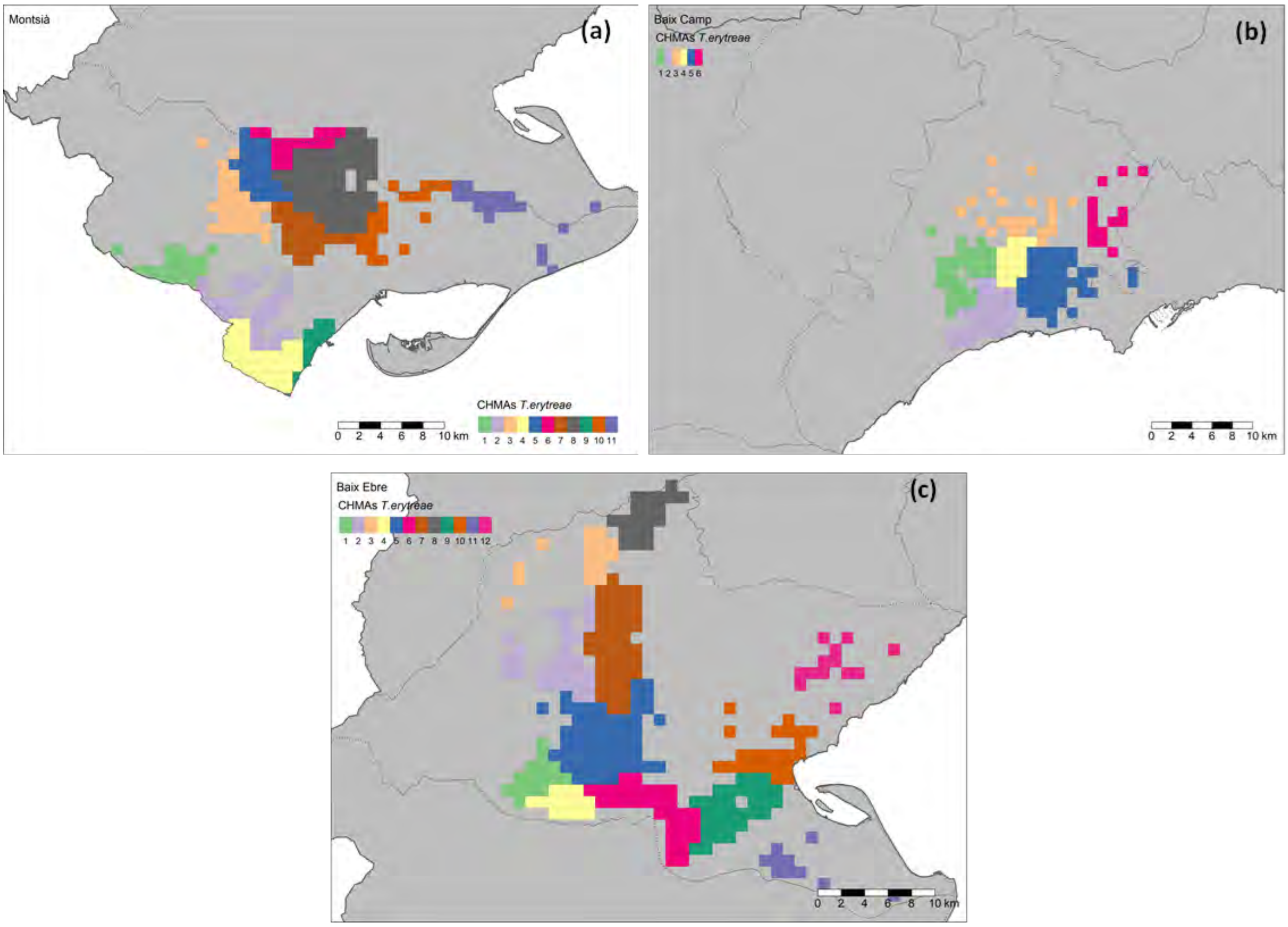

Figure 4. CHMAs for *T. erytreae* within Tarragona province at comarca level.

Montsià	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.24	2.75	19
	2	0.22	1.55	31
	3	0.13	1.25	27
	4	0.53	9.24	34
	5	0.43	6.41	22
	6	0.74	8.21	15
	7	0.30	1.63	23
	8	0.43	11.68	63
	9	0.27	0.50	13
	10	0.23	0.49	20
	11	0.28	0.89	19
T. erytreae	1	0.24	2.75	19
	2	0.22	1.55	31
	3	0.13	1.25	27
	4	0.53	9.24	34
	5	0.43	6.41	22
	6	0.74	8.21	15
	7	0.30	1.63	23
	8	0.43	11.68	63
	9	0.27	0.50	13
	10	0.23	0.49	20
	11	0.28	0.89	19

Baix Camp	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.13	0.17	28
	2	0.19	1.10	30
	3	0.04	0.04	22
	4	0.13	0.16	14
	5	0.17	0.77	42
	6	0.07	0.02	14
T. erytreae	1	0.13	0.17	28
	2	0.19	1.10	30
	3	0.04	0.04	22
	4	0.13	0.16	14
	5	0.17	0.77	42
	6	0.07	0.02	14

Baix Ebre	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.38	4.03	15
	2	0.11	1.13	30
	3	0.14	1.11	16
	4	0.81	8.49	13
	5	0.23	4.39	54
	6	0.44	5.04	31
	7	0.36	9.05	42
	8	0.09	0.65	20
	9	0.33	2.22	31
	10	0.24	0.30	23
	11	0.28	0.45	10
	12	0.15	0.03	13
T. erytreae	1	0.38	4.03	15
	2	0.11	1.13	30
	3	0.14	1.11	16
	4	0.81	8.49	13
	5	0.23	4.39	54
	6	0.44	5.04	31
	7	0.36	9.05	42
	8	0.09	0.65	20
	9	0.33	2.22	31
	10	0.24	0.30	23
	11	0.28	0.45	10
	12	0.15	0.03	13

4.3 Risk maps and CHMAs for Comunidad Valenciana

Risk maps for Castellón province

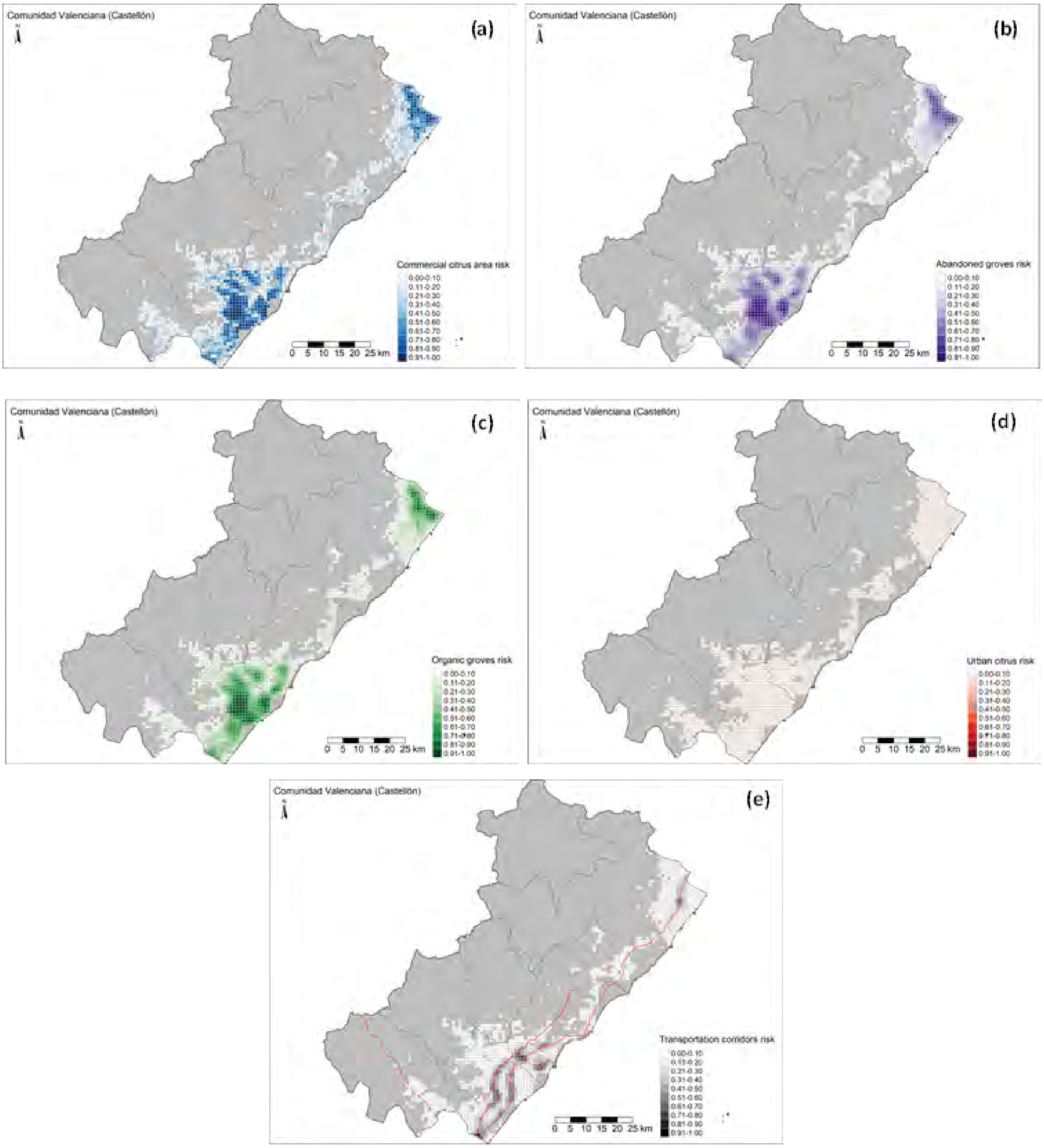

Figure 5. Risk maps for Castellón province within the Comunidad Valenciana autonomous community.

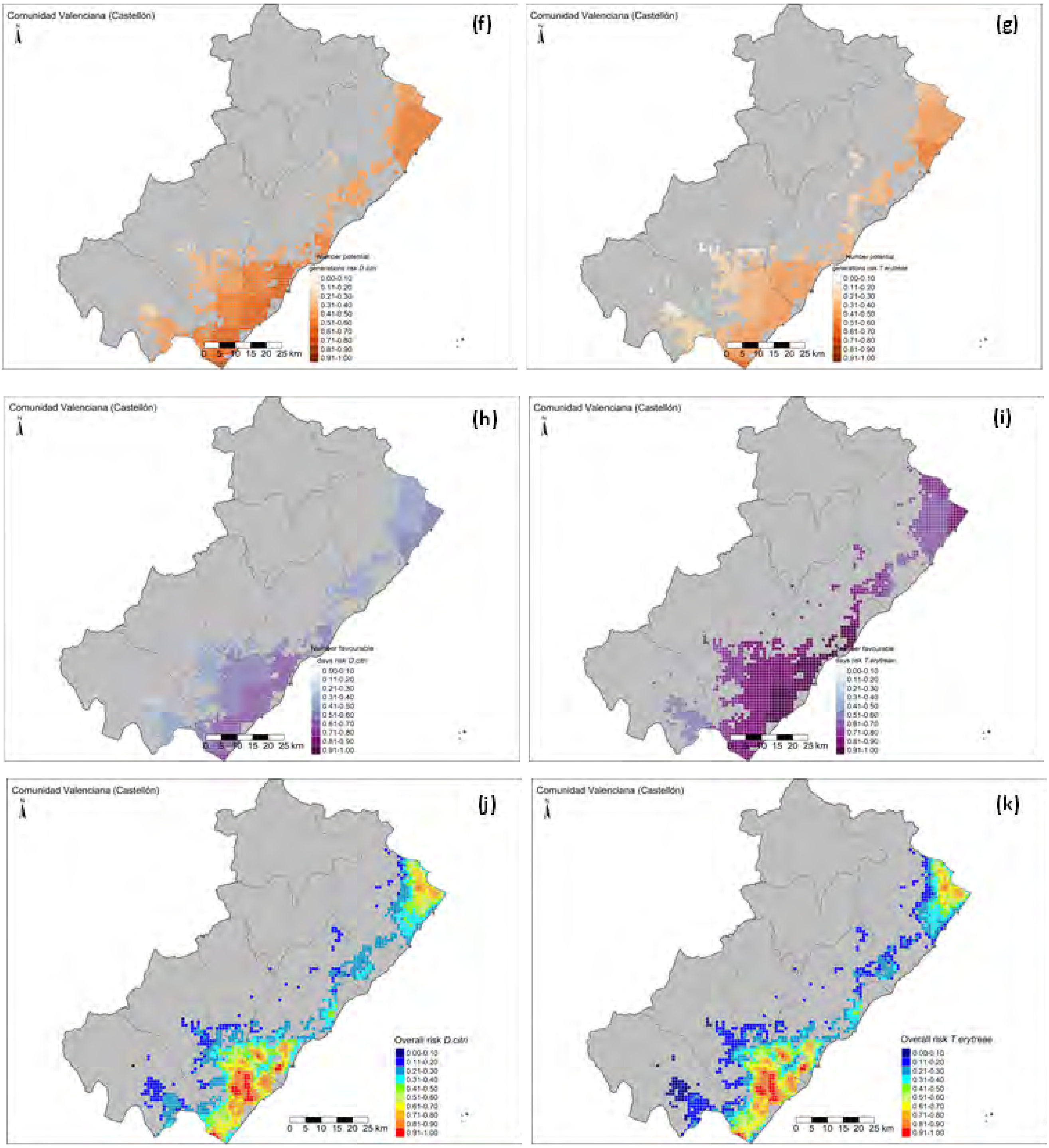

Figure 5. Risk maps for Castellón province within the Comunidad Valenciana autonomous community.

CHMAs for Castellón province: graphical and numerical description

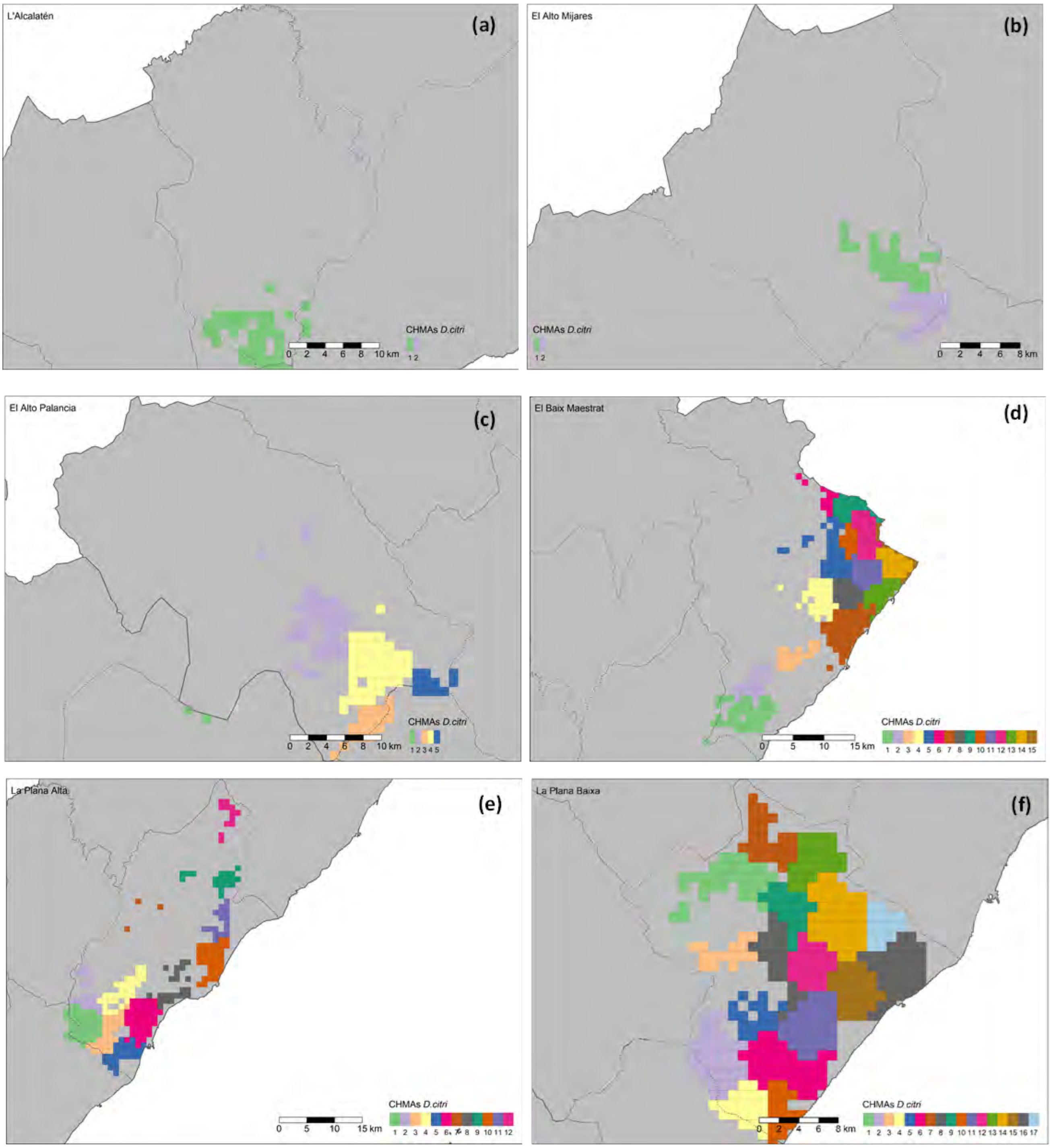

Figure 6. CHMAs for *D. citri* within Castellón province at comarca level.

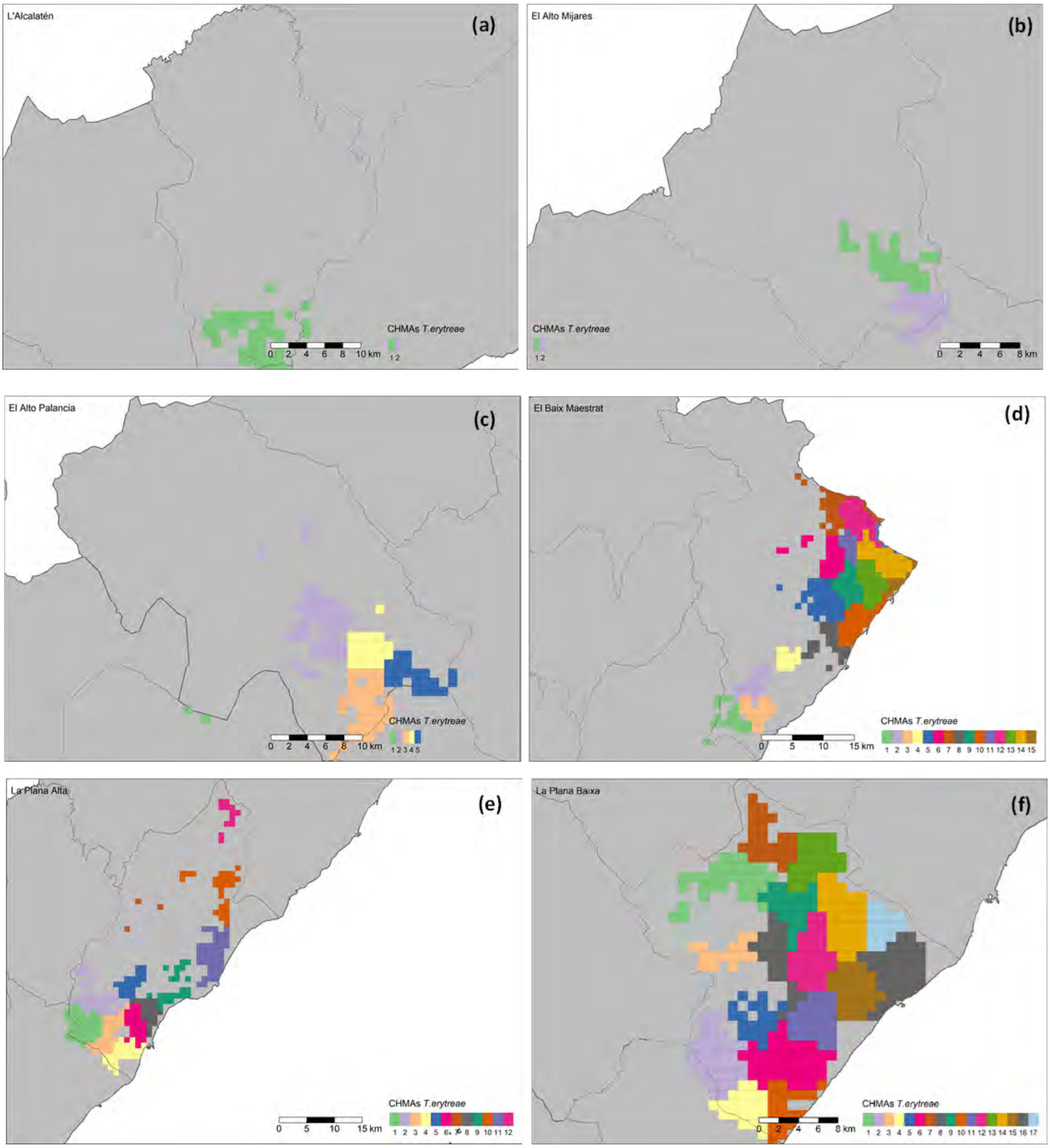

Figure 7. CHMAs for *T. erytreae* within Castellón province at comarca level.

L'Alcaltén	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.23	3.55	43
	2	0.13	0.00	2
T. erytreae	1	0.19	3.55	43
	2	0.13	0.00	2

El Alto Mijares	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.17	1.23	25
	2	0.20	1.16	20
T. erytreae	1	0.13	1.23	25
	2	0.16	1.16	20

El Alto Palancia	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.18	0.00	2
	2	0.14	0.57	42
	3	0.28	2.07	18
	4	0.22	3.54	45
	5	0.28	1.38	11
T. erytreae	1	0.09	0.00	2
	2	0.08	0.57	42
	3	0.17	3.26	34
	4	0.16	2.04	19
	5	0.17	1.69	21

El Baix Maestrat	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.27	6.64	44
	2	0.24	1.97	21
	3	0.24	1.33	20
	4	0.27	3.19	30
	5	0.25	3.36	37
	6	0.19	0.58	11
	7	0.33	7.11	48
	8	0.40	5.38	20
	9	0.40	8.25	24
	10	0.44	4.27	12
	11	0.59	11.02	23
	12	0.70	19.25	27
	13	0.41	5.99	22
	14	0.67	14.69	22
	15	0.38	1.77	13
T. erytreae	1	0.22	3.20	21
	2	0.20	1.97	21
	3	0.23	3.44	23
	4	0.18	0.80	14
	5	0.24	5.20	38
	6	0.19	1.94	26
	7	0.22	3.71	32
	8	0.22	2.13	23
	9	0.37	5.93	23
	10	0.28	4.51	32
	11	0.40	5.60	19
	12	0.57	17.49	28
	13	0.54	13.33	27
	14	0.69	24.47	35
	15	0.31	1.08	12

La Plana Alta	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.62	18.75	40
	2	0.29	2.13	21
	3	0.42	4.47	28
	4	0.30	2.07	32
	5	0.67	13.31	26
	6	0.57	15.12	41
	7	0.16	0.00	3
	8	0.27	1.36	22
	9	0.20	1.49	19
	10	0.33	4.79	34
	11	0.24	1.85	17
	12	0.14	0.25	12
T. erytreae	1	0.61	18.57	39
	2	0.28	3.08	35
	3	0.39	4.47	28
	4	0.64	13.31	26
	5	0.25	1.31	19
	6	0.65	11.51	22
	7	0.15	0.00	3
	8	0.41	3.60	19
	9	0.25	1.36	22
	10	0.18	1.86	28
	11	0.30	6.27	42
	12	0.12	0.25	12

La Plana Baixa	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.27	4.40	33
	2	0.35	6.77	35
	3	0.21	0.38	15
	4	0.76	11.96	21
	5	0.30	0.62	16
	6	0.57	12.94	37
	7	0.31	4.75	24
	8	0.39	3.72	22
	9	0.60	9.68	19
	10	0.50	4.04	18
	11	0.74	18.50	31
	12	0.86	17.08	21
	13	0.50	10.82	24
	14	0.80	29.01	41
	15	0.89	19.99	25
	16	0.69	21.74	36
	17	0.53	4.63	15
T. erytreae	1	0.23	4.40	33
	2	0.30	6.77	35
	3	0.16	0.38	15
	4	0.72	11.96	21
	5	0.26	0.88	18
	6	0.57	16.00	39
	7	0.28	4.75	24
	8	0.35	3.72	22
	9	0.59	10.72	21
	10	0.44	4.50	21
	11	0.74	14.73	24
	12	0.86	22.01	27
	13	0.48	10.82	24
	14	0.79	23.04	33
	15	0.88	19.99	25
	16	0.67	21.74	36
	17	0.49	4.63	15

Risk maps for Valencia province

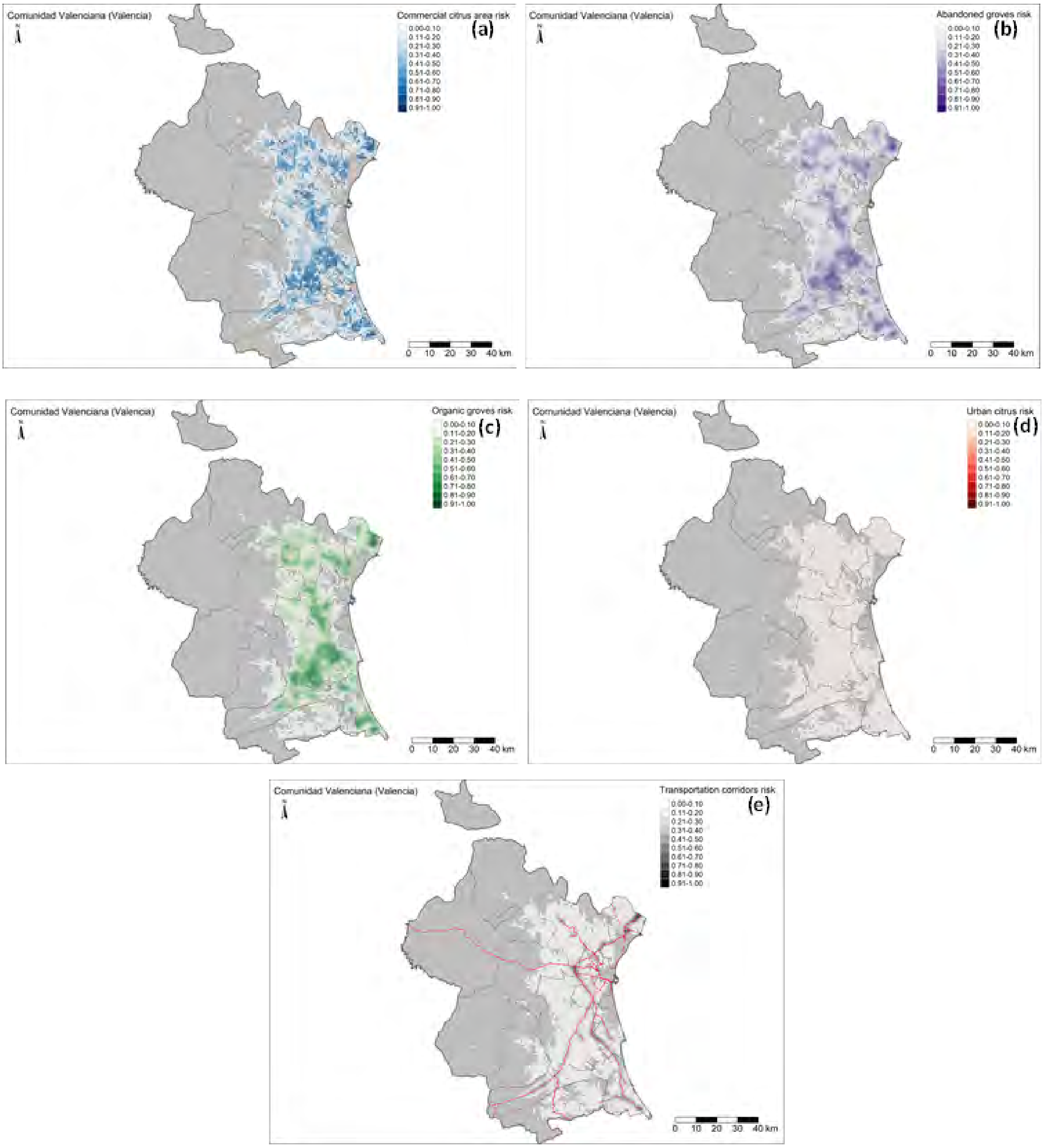

Figure 8. Risk maps for Valencia province within the Comunidad Valenciana autonomous community.

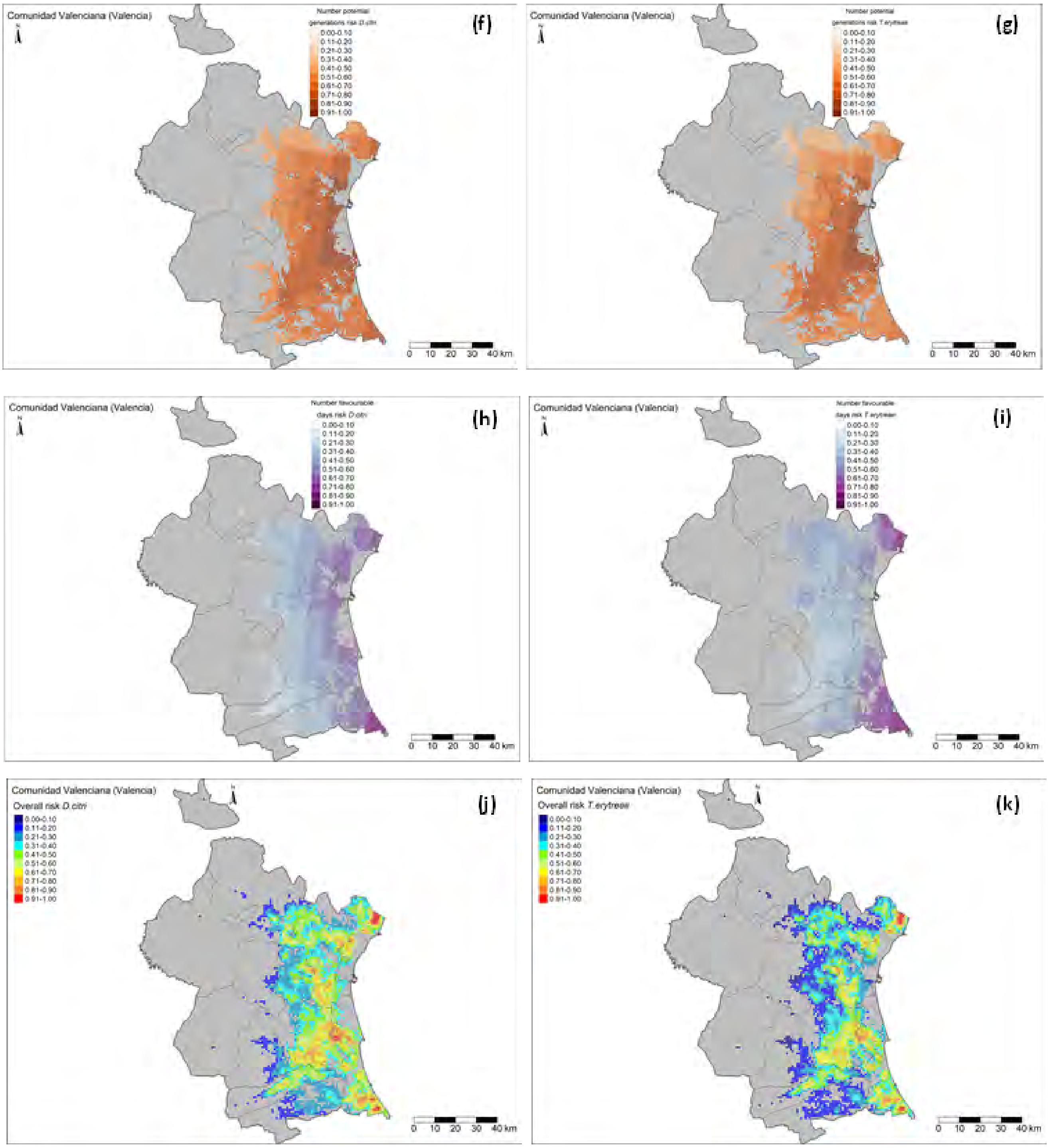

Figure 8. Risk maps for Valencia province within the Comunidad Valenciana autonomous community.

CHMAs for Valencia province: graphical and numerical description

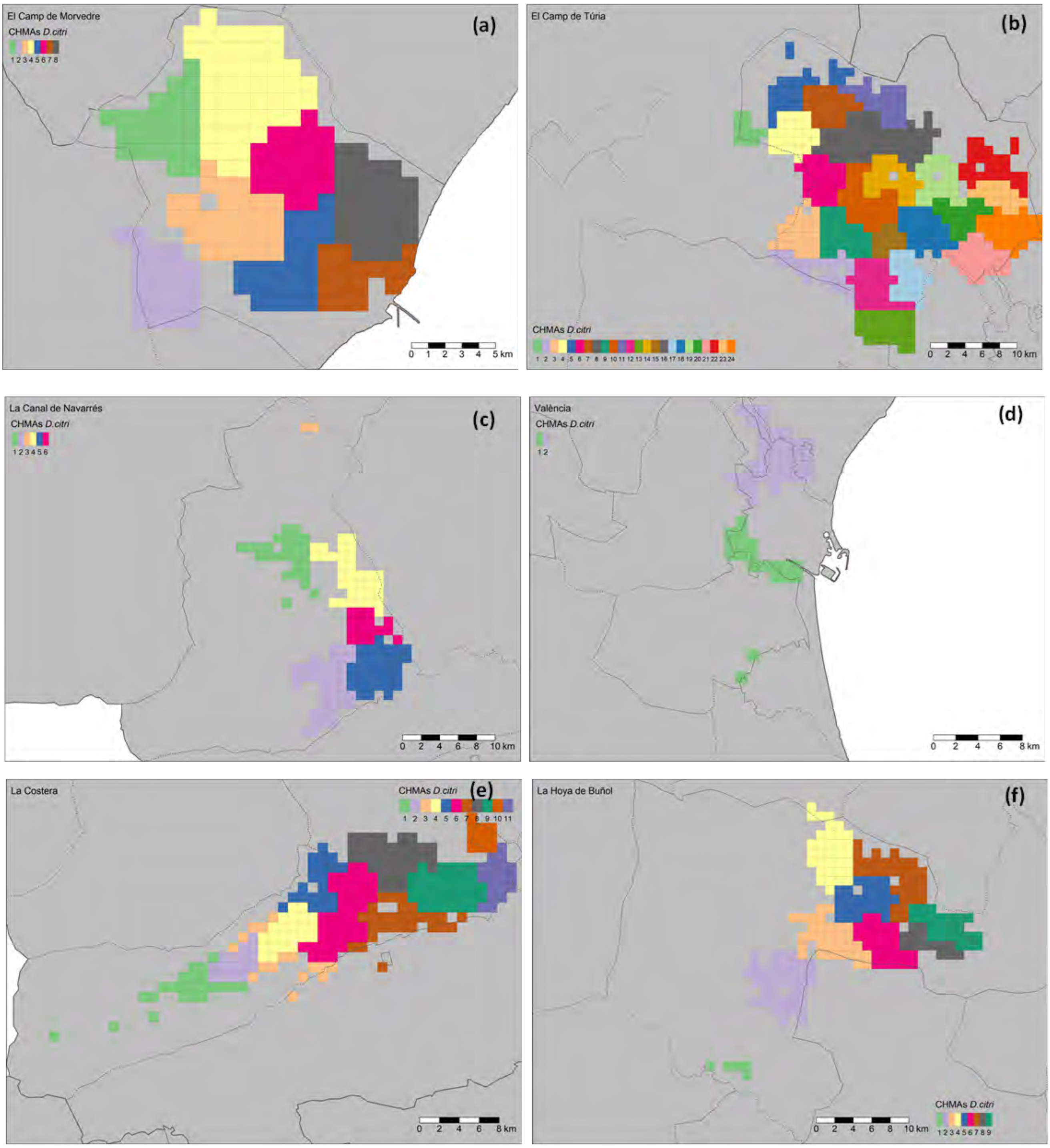

Figure 9. CHMAs for *D. citri* within Valencia province at comarca level.

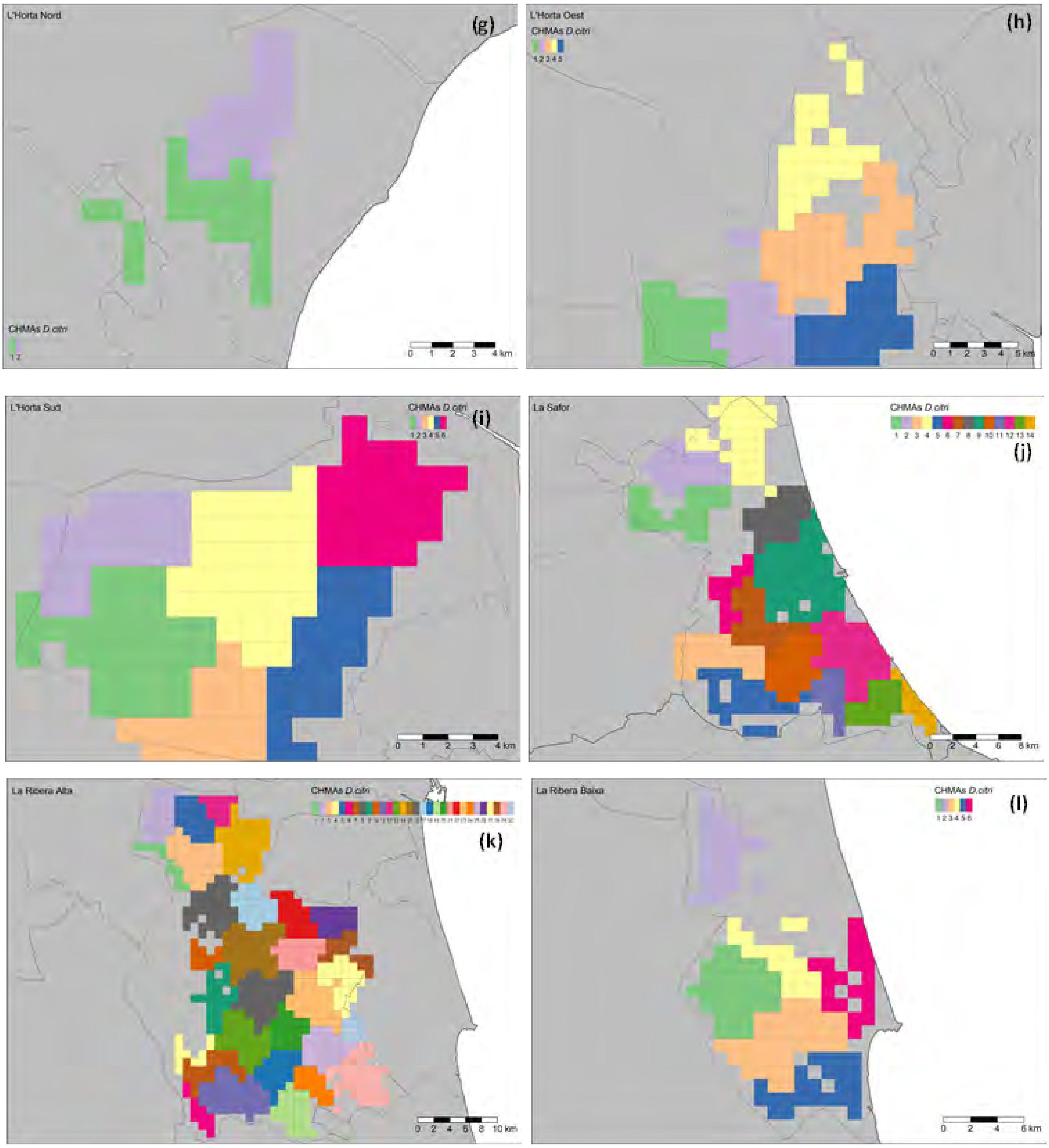

Figure 9. CHMAs for *D. citri* within Valencia province at comarca level.

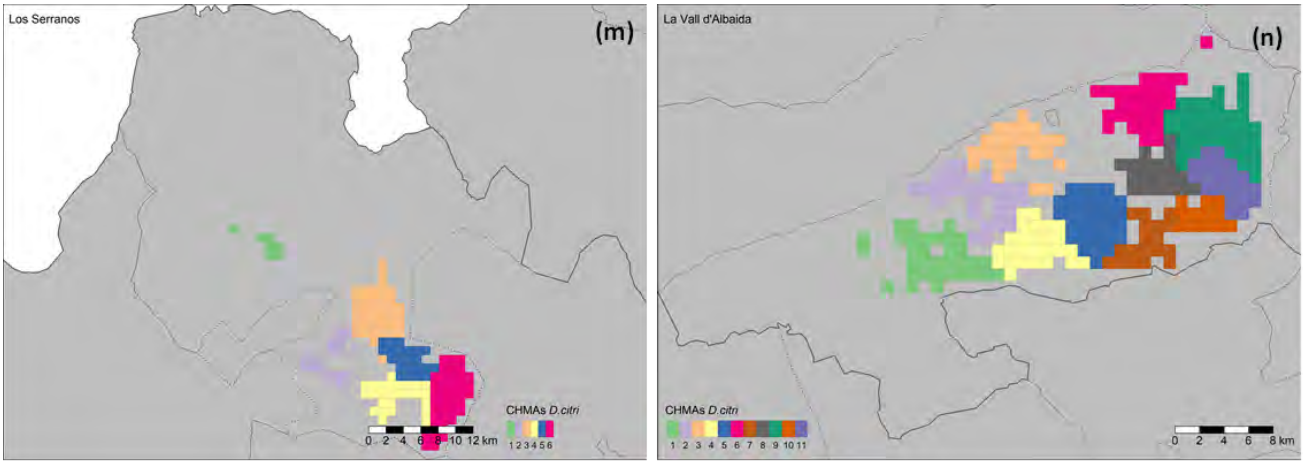

Figure 9. CHMAs for *D. citri* within Valencia province at comarca level.

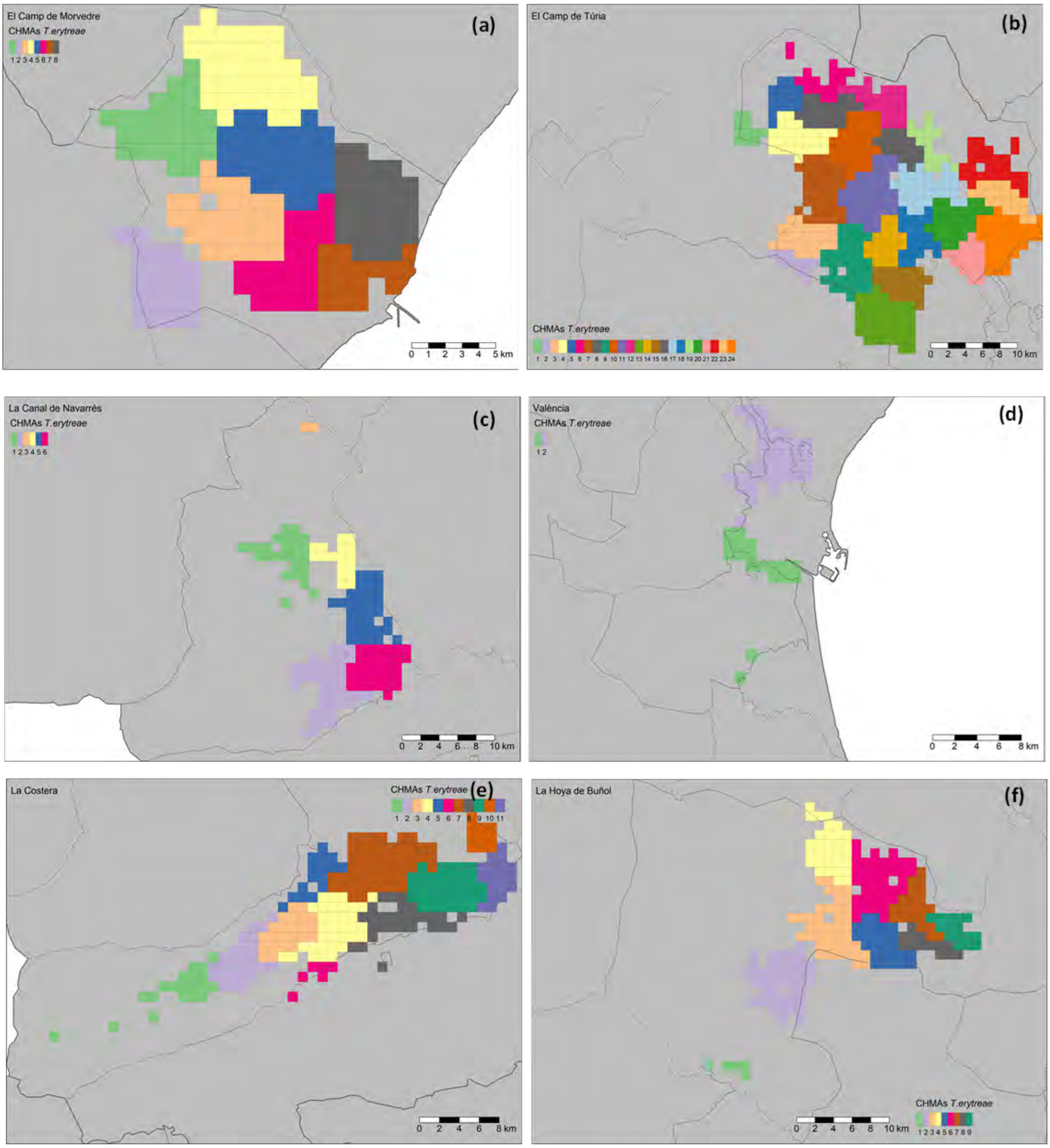

Figure 10. CHMAs for *T. erytreae* within Valencia province at comarca level.

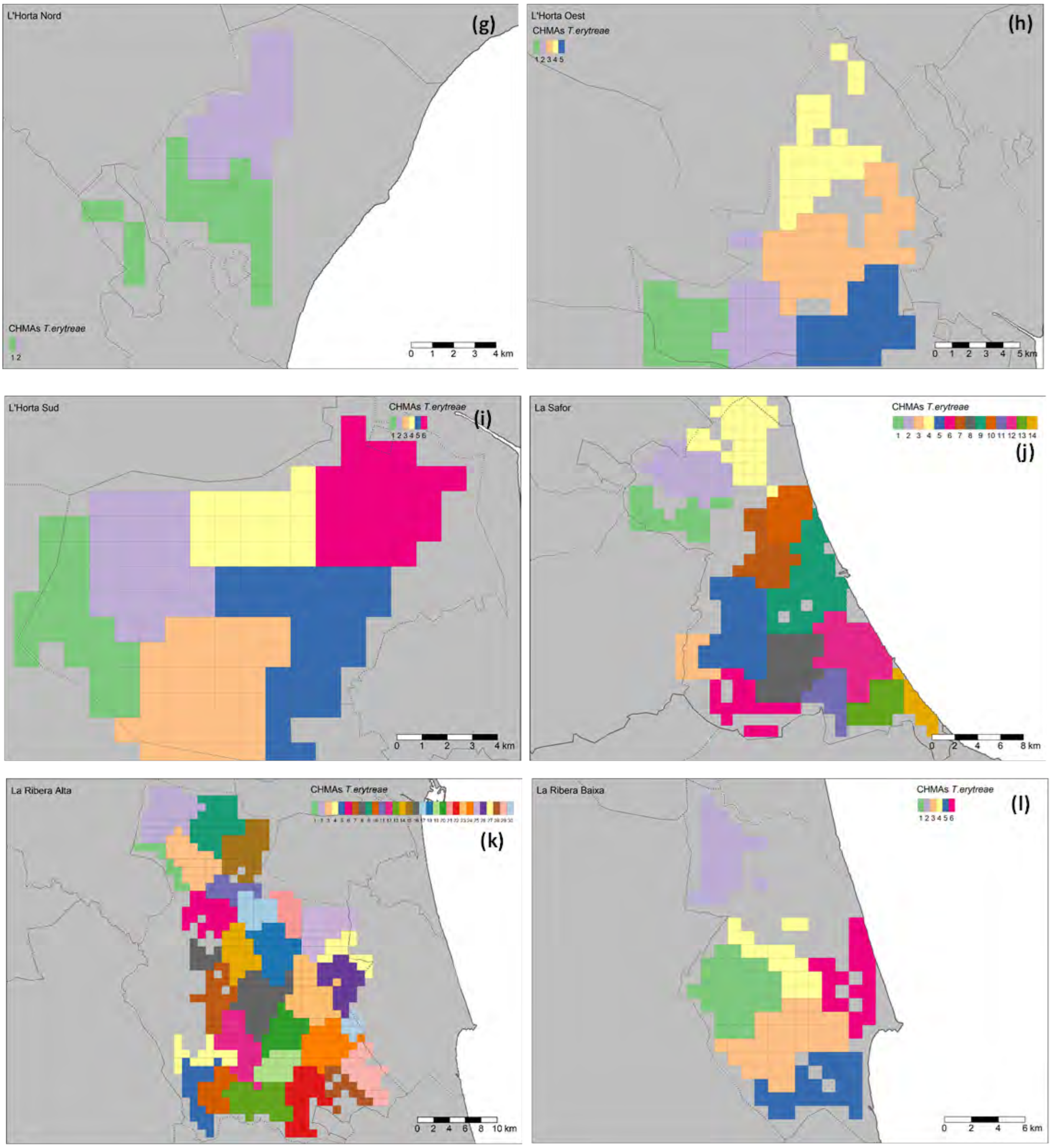

Figure 10. CHMAs for *T. erytreae* within Valencia province at comarca level.

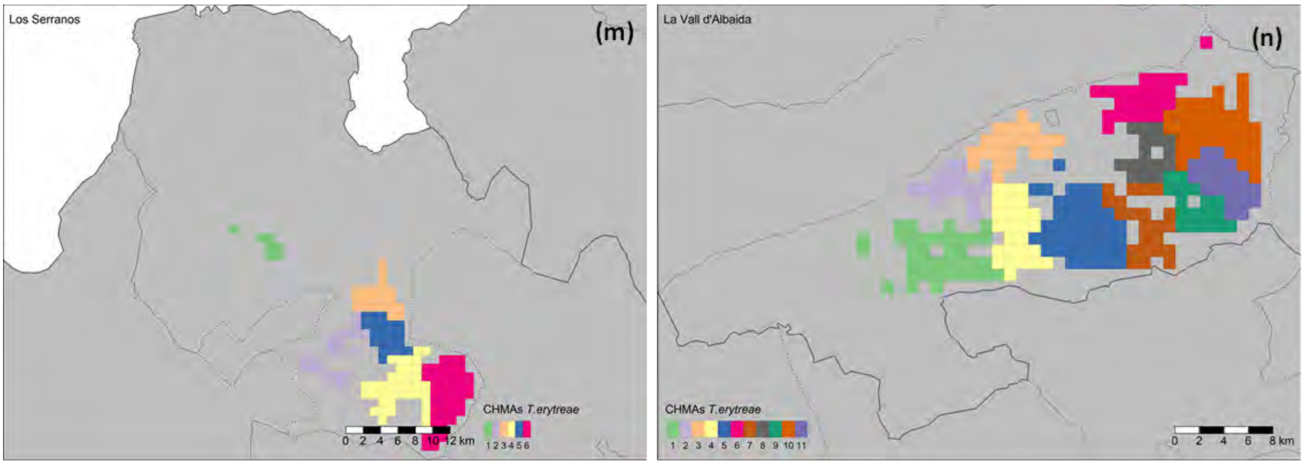

Figure 10. CHMAs for *T. erytreae* within Valencia province at comarca level.

El Camp de Morvedre	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.37	4.90	24
	2	0.35	3.24	21
	3	0.38	3.75	28
	4	0.44	14.99	48
	5	0.67	10.76	23
	6	0.47	5.63	22
	7	0.45	3.25	17
	8	0.83	19.81	29
T. erytreae	1	0.29	5.55	27
	2	0.25	3.24	21
	3	0.29	3.75	28
	4	0.36	10.80	36
	5	0.42	9.17	31
	6	0.61	10.76	23
	7	0.38	3.25	17
	8	0.79	19.81	29

El Camp de Túria	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.31	2.77	11
	2	0.29	2.12	25
	3	0.50	11.95	26
	4	0.38	7.70	26
	5	0.21	1.35	28
	6	0.49	11.53	26
	7	0.38	7.85	25
	8	0.47	14.15	34
	9	0.48	11.21	28
	10	0.41	7.24	33
	11	0.33	5.55	25
	12	0.40	6.05	29
	13	0.53	9.45	29
	14	0.34	3.02	25
	15	0.57	6.39	12
	16	0.42	9.92	27
	17	0.35	2.93	23
	18	0.39	5.62	28
	19	0.37	5.81	25
	20	0.58	10.19	20
	21	0.45	6.58	29
	22	0.24	1.11	29
	23	0.48	5.39	17
	24	0.67	16.26	30
T. erytreae	1	0.24	2.77	11
	2	0.19	1.05	11
	3	0.47	14.73	27
	4	0.32	8.45	28
	5	0.15	1.33	16
	6	0.13	0.89	18
	7	0.38	14.31	37
	8	0.33	7.53	22
	9	0.28	8.43	37
	10	0.40	13.72	33
	11	0.27	6.85	41
	12	0.24	5.55	25
	13	0.39	11.77	41
	14	0.46	9.75	20
	15	0.23	2.30	23
	16	0.44	8.86	17
	17	0.30	7.80	32
	18	0.25	2.36	22
	19	0.18	1.56	16
	20	0.45	12.79	28
	21	0.26	2.30	18
	22	0.14	1.11	29
	23	0.38	6.22	20
	24	0.57	19.72	38

La Canal de Navarrés	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.14	0.28	27
	2	0.19	1.63	39
	3	0.15	0.00	2
	4	0.20	1.83	34
	5	0.29	5.60	34
	6	0.21	0.74	16
T. erytreae	1	0.09	0.28	27
	2	0.12	1.66	41
	3	0.08	0.00	2
	4	0.12	0.78	17
	5	0.14	1.90	34
	6	0.23	5.46	31

València	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.37	1.24	19
2	2	0.43	5.72	36
T. erytreae	1	0.24	1.20	18
	2	0.31	5.76	37

La Costera	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.22	1.70	23
2	2	0.48	6.62	16
3	3	0.29	1.40	16
4	4	0.60	13.14	23
5	5	0.37	3.94	21
6	6	0.51	16.65	41
7	7	0.30	2.17	28
8	8	0.46	10.51	36
9	9	0.49	14.40	34
10	10	0.62	5.80	10
11	11	0.32	2.35	18
T. erytreae	1	0.16	1.42	20
	2	0.36	7.90	27
	3	0.57	13.14	23
	4	0.42	11.27	34
	5	0.30	2.93	16
	6	0.16	0.11	6
	7	0.44	17.18	50
	8	0.23	2.17	28
	9	0.44	14.40	34
	10	0.55	5.80	10
	11	0.25	2.35	18

La Hoya de Buñol	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.15	0.01	5
	2	0.20	2.85	41
	3	0.26	3.40	32
	4	0.32	6.81	34
	5	0.26	1.81	26
	6	0.40	7.92	26
	7	0.33	4.65	33
	8	0.33	0.76	14
	9	0.66	13.62	23
T. erytreae	1	0.08	0.01	5
	2	0.13	2.87	43
	3	0.17	4.17	41
	4	0.24	6.70	31
	5	0.32	7.92	26
	6	0.16	2.24	39
	7	0.38	7.79	21
	8	0.22	0.55	13
	9	0.64	9.58	15

L'Horta Nord	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.51	6.78	24
	2	0.69	12.45	22
T. erytreae	1	0.40	6.78	24
	2	0.60	12.45	22

L'Horta Oest	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.42	6.60	22
	2	0.65	10.79	22
	3	0.41	6.01	40
	4	0.38	3.95	26
	5	0.56	9.47	27
T. erytreae	1	0.32	6.60	22
	2	0.56	10.79	22
	3	0.30	6.01	40
	4	0.27	3.95	26
	5	0.46	9.47	27

L'Horta Sud	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.59	14.61	30
	2	0.62	9.70	20
	3	0.62	8.13	18
	4	0.60	12.59	33
	5	0.44	3.33	21
	6	0.39	1.75	24
T. erytreae	1	0.38	6.48	21
	2	0.58	13.66	24
	3	0.55	16.43	32
	4	0.56	7.38	16
	5	0.34	4.41	29
	6	0.26	1.75	24

La Safor	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.34	3.63	27
	2	0.57	11.40	25
	3	0.49	7.40	25
	4	0.51	11.40	38
	5	0.37	2.70	26
	6	0.42	2.80	12
	7	0.65	11.09	22
	8	0.55	8.68	23
	9	0.46	11.13	51
	10	0.76	14.18	22
	11	0.47	1.69	12
	12	0.69	16.50	34
	13	0.83	10.02	15
	14	0.47	1.56	10
T. erytreae	1	0.22	1.40	22
	2	0.51	13.63	30
	3	0.30	1.09	11
	4	0.46	11.40	38
	5	0.52	17.32	40
	6	0.27	1.39	20
	7	0.38	4.07	21
	8	0.69	16.67	28
	9	0.41	9.31	43
	10	0.57	7.99	17
	11	0.39	1.84	13
	12	0.62	16.50	34
	13	0.76	10.02	15
	14	0.37	1.56	10

La Ribera Alta	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.25	0.62	11
	2	0.32	4.78	25
	3	0.39	11.12	35
	4	0.30	1.01	11
	5	0.29	2.97	23
	6	0.43	3.03	11
	7	0.48	7.69	22
	8	0.26	2.49	36
	9	0.32	3.28	25
	10	0.24	0.45	11
	11	0.68	25.30	41
	12	0.42	4.00	13
	13	0.58	15.86	34
	14	0.29	3.91	43
	15	0.40	11.13	44
	16	0.48	10.79	37
	17	0.37	5.31	25
	18	0.76	18.25	24
	19	0.65	15.12	26
	20	0.66	11.81	21
	21	0.47	5.90	23
	22	0.34	1.95	22
	23	0.65	16.83	35
	24	0.65	9.50	16
	25	0.54	10.01	27
	26	0.54	6.44	20
	27	0.78	17.53	27
	28	0.56	5.75	17
	29	0.42	8.70	39
	30	0.78	6.62	10
T. erytreae	1	0.16	0.62	11
	2	0.23	6.68	38
	3	0.32	10.40	31
	4	0.26	2.02	18
	5	0.42	9.02	23
	6	0.16	1.87	27
	7	0.23	3.28	25
	8	0.15	0.45	11
	9	0.25	6.67	36
	10	0.63	13.22	19
	11	0.19	1.30	15
	12	0.51	14.42	32
	13	0.63	20.37	33
	14	0.31	6.62	25
	15	0.19	3.02	34
	16	0.41	11.65	38
	17	0.29	4.63	19
	18	0.32	7.72	33
	19	0.72	14.53	19
	20	0.59	13.37	24
	21	0.20	0.80	16
	22	0.58	19.04	33
	23	0.56	17.63	37
	24	0.47	12.06	32
	25	0.40	9.08	33
	26	0.70	17.53	27
	27	0.47	5.75	17
	28	0.26	0.99	14
	29	0.39	7.83	26
	30	0.74	5.57	8

La Ribera Baixa	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.81	21.65	32
	2	0.42	3.71	24
	3	0.64	15.46	38
	4	0.52	4.01	18
	5	0.47	5.84	24
	6	0.41	2.50	22
T. erytreae	1	0.73	21.65	32
	2	0.31	3.71	24
	3	0.56	15.46	38
	4	0.42	4.01	18
	5	0.40	5.84	24
	6	0.30	2.50	22

Los Serranos	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.10	0.13	7
	2	0.12	0.36	16
	3	0.22	3.91	39
	4	0.23	2.25	27
	5	0.37	6.95	22
	6	0.48	16.76	39
T. erytreae	1	0.05	0.13	7
	2	0.06	0.62	20
	3	0.09	0.67	21
	4	0.18	4.64	39
	5	0.30	6.77	21
	6	0.39	17.54	42

La Vall d'Albaida	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.17	0.43	33
	2	0.21	0.91	29
	3	0.22	0.75	25
	4	0.21	0.84	26
	5	0.25	2.45	30
	6	0.26	1.83	28
	7	0.21	0.30	18
	8	0.24	0.59	19
	9	0.28	3.15	39
	10	0.23	0.34	12
	11	0.35	4.24	21
T. erytreae	1	0.12	0.43	36
	2	0.13	0.10	16
	3	0.16	0.73	22
	4	0.16	1.19	26
	5	0.18	2.99	42
	6	0.19	1.62	23
	7	0.15	0.28	22
	8	0.16	0.52	16
	9	0.17	0.57	17
	10	0.22	3.15	39
	11	0.30	4.24	21

Risk maps for Alicante province

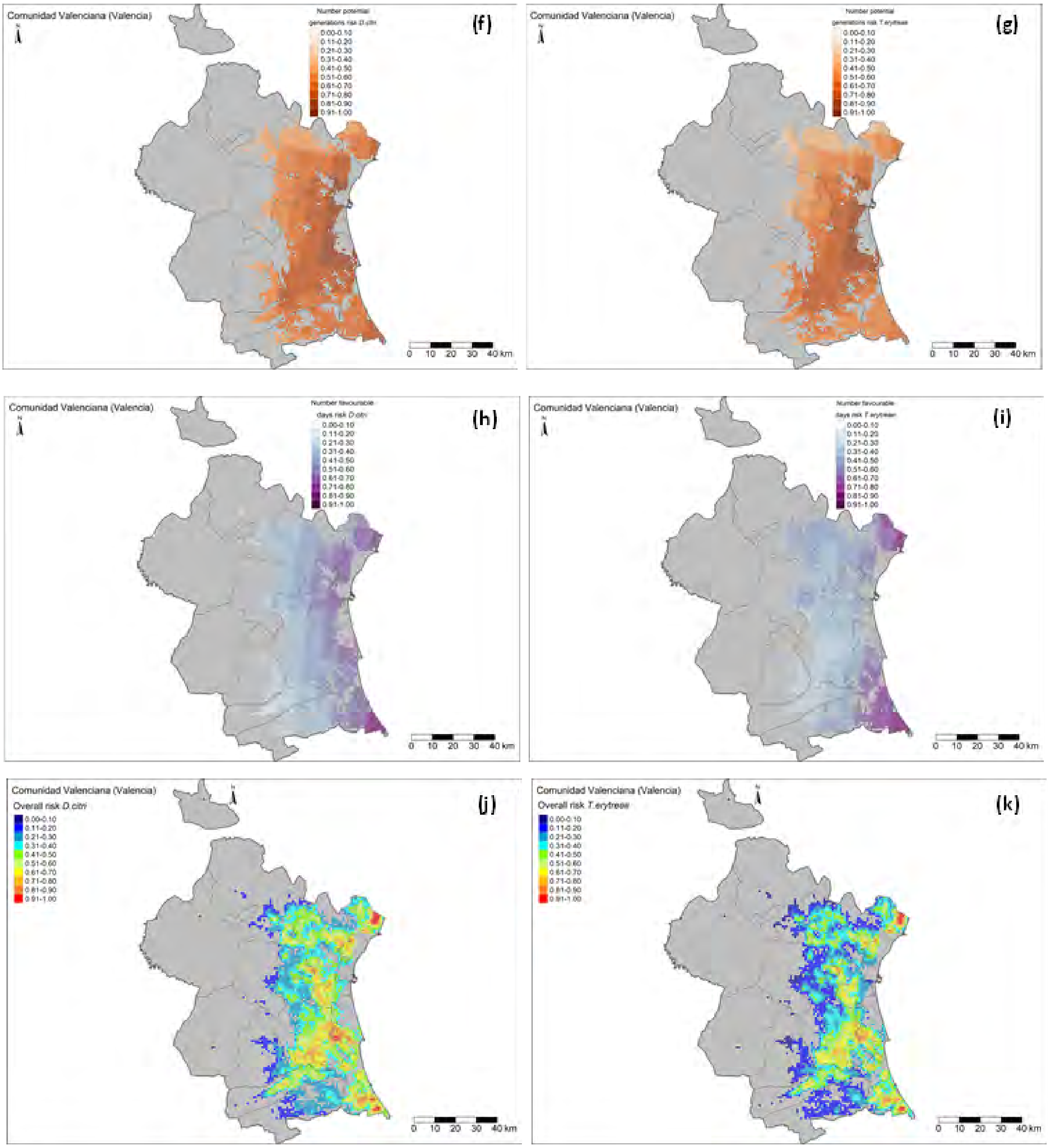

Figure 11. Risk maps for Alicante province within the Comunidad Valenciana autonomous community.

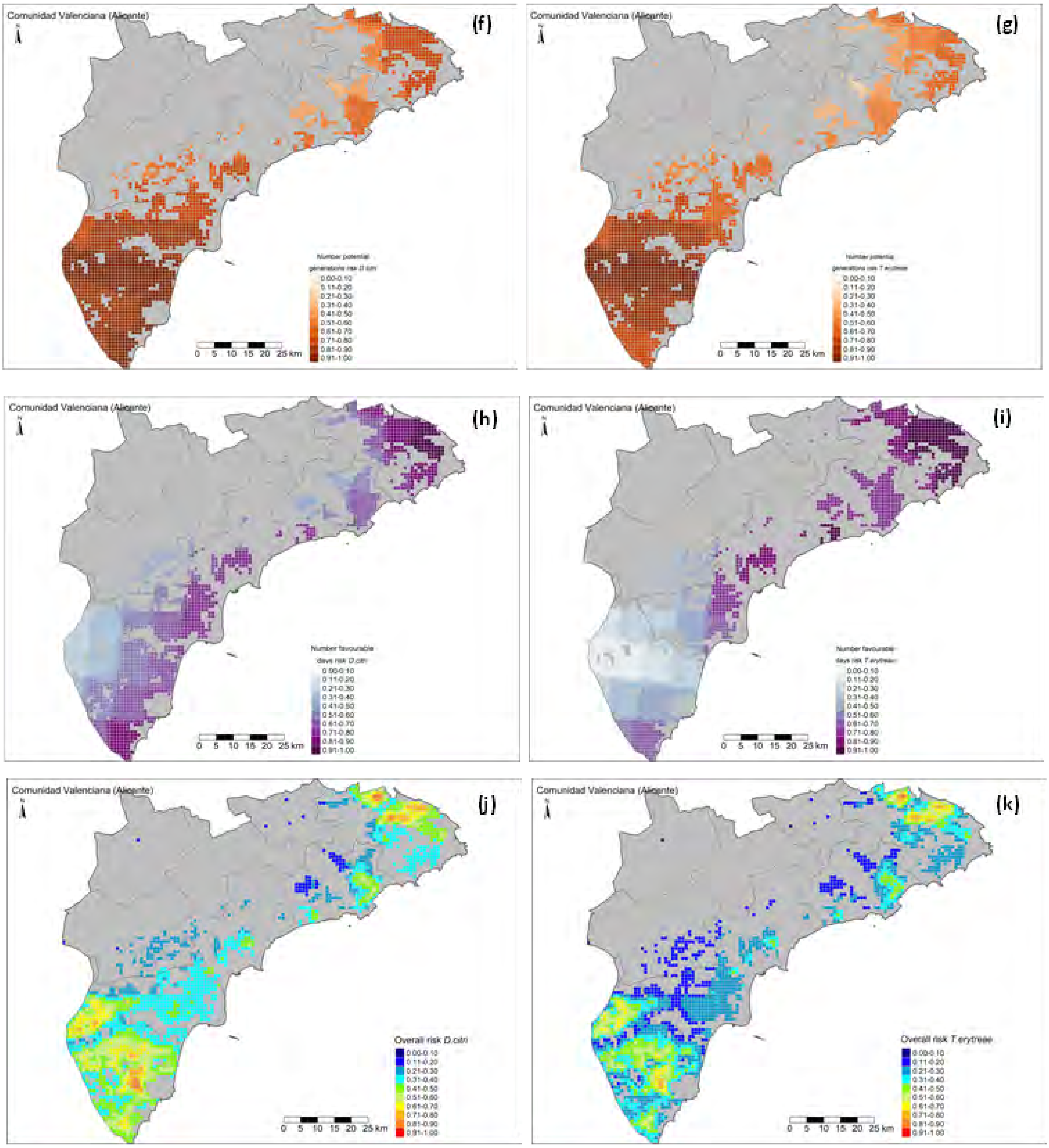

Figure 11. Risk maps for Alicante province within the Comunidad Valenciana autonomous community.

CHMAs for Alicante province: graphical and numerical description

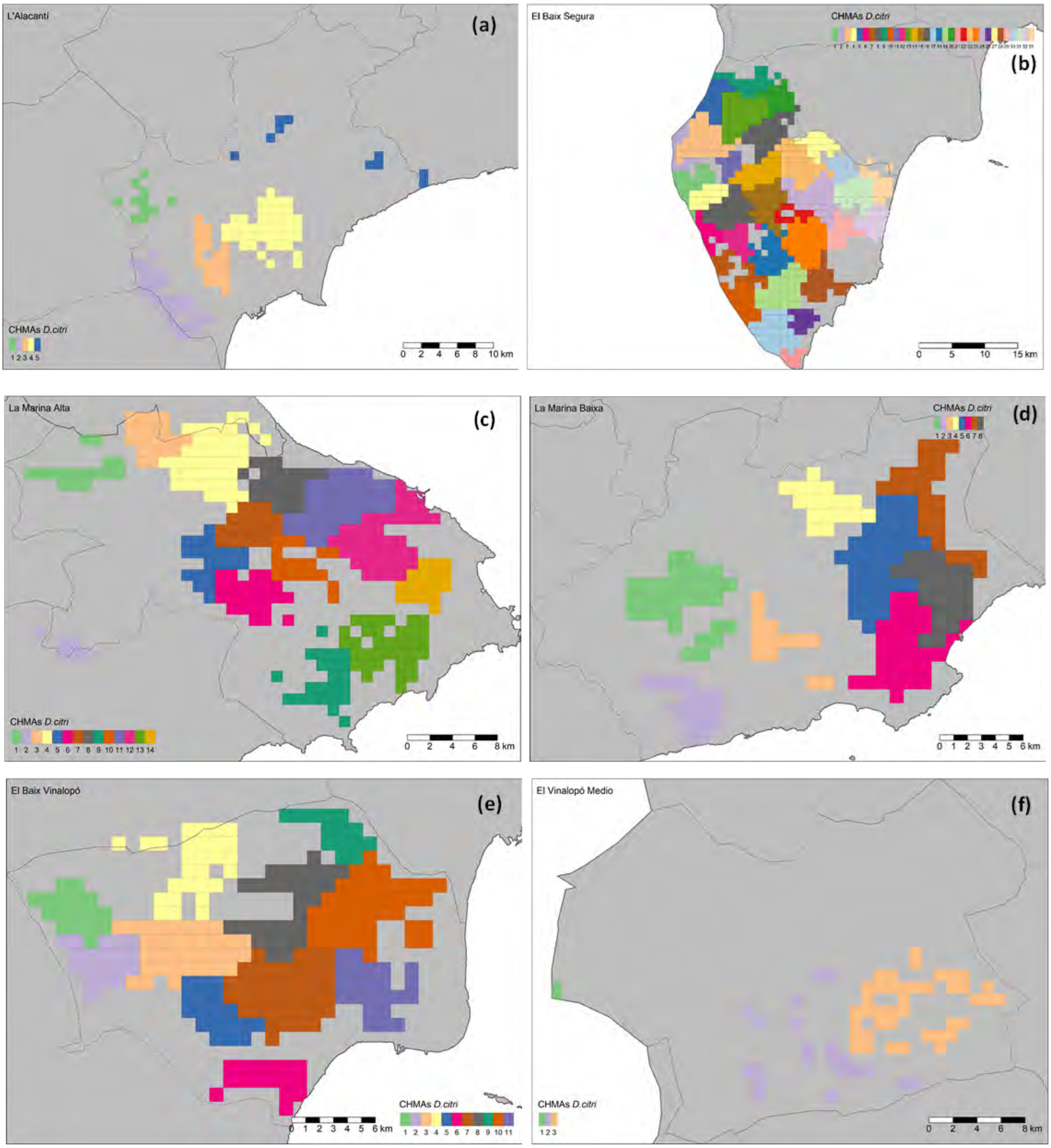

Figure 12. CHMAs for *D. citri* within Alicante province at comarca level.

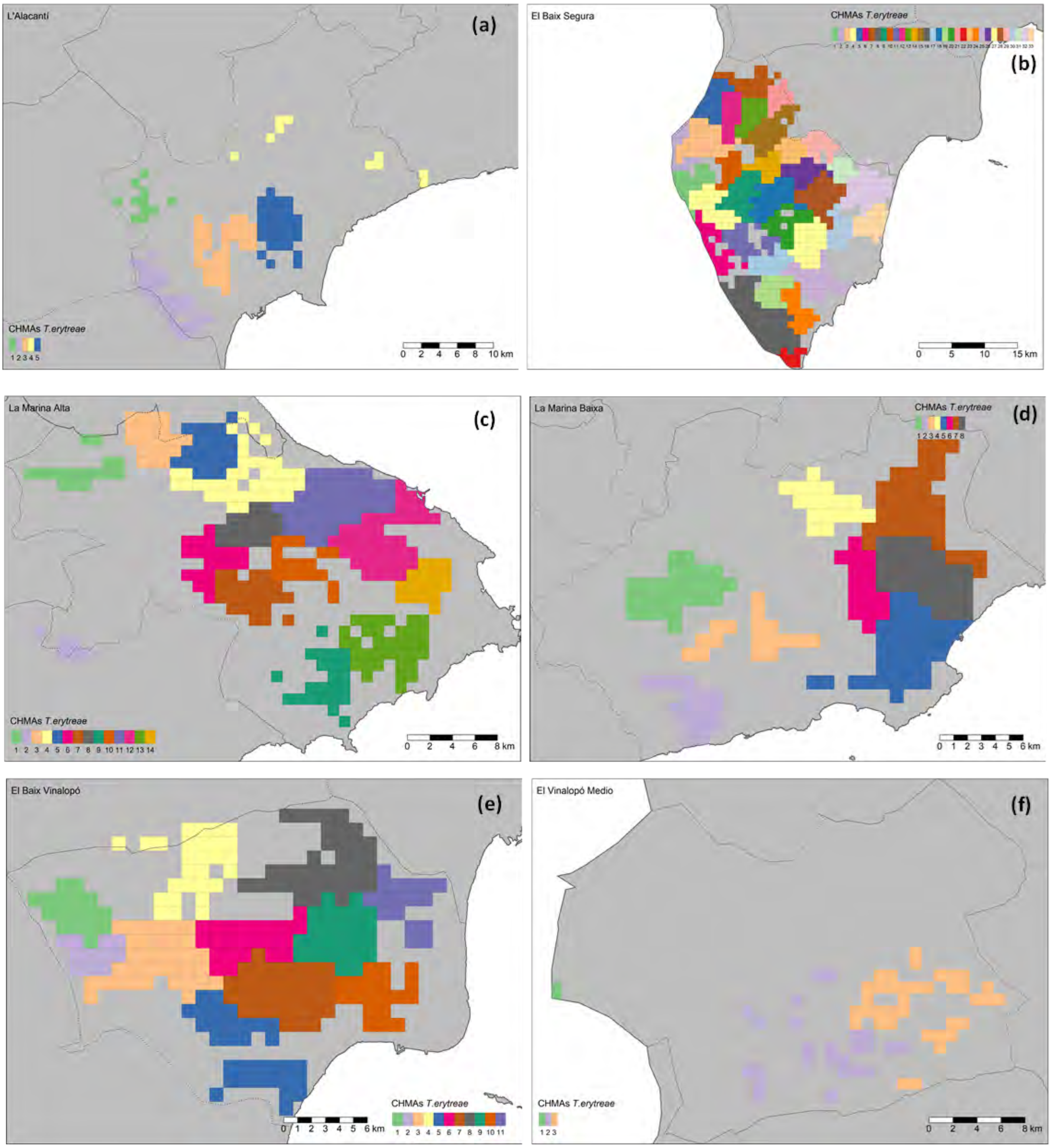

Figure 13. CHMAs for *T. erytreae* within Alicante province at comarca level.

L'Alacantí	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.26	0.05	11
	2	0.35	1.89	29
	3	0.33	0.97	22
	4	0.37	2.50	43
	5	0.28	0.08	10
T. erytreae	1	0.18	0.05	11
	2	0.25	1.89	29
	3	0.26	1.00	34
	4	0.22	0.08	10
	5	0.30	2.46	31

El Baix Segura	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.34	3.22	26
	2	0.42	3.41	17
	3	0.61	20.98	40
	4	0.53	7.45	18
	5	0.45	8.80	25
	6	0.40	3.36	14
	7	0.36	2.35	22
	8	0.54	13.37	33
	9	0.32	2.49	23
	10	0.41	5.14	27
	11	0.34	0.78	12
	12	0.42	4.06	18
	13	0.62	21.98	39
	14	0.52	9.71	27
	15	0.60	15.71	32
	16	0.34	2.65	33
	17	0.54	14.07	41
	18	0.48	7.59	30
	19	0.44	5.55	38
	20	0.45	6.43	19
	21	0.44	0.81	10
	22	0.43	0.74	10
	23	0.48	8.14	35
	24	0.71	23.51	41
	25	0.61	17.58	39
	26	0.46	1.57	14
	27	0.34	0.97	18
	28	0.46	4.72	28
	29	0.49	2.96	19
	30	0.39	0.91	14
	31	0.49	5.86	27
	32	0.47	4.25	21
	33	0.39	0.98	17
T. erytreae	1	0.23	3.22	26
	2	0.32	3.41	17
	3	0.53	19.73	38
	4	0.47	15.67	31
	5	0.37	10.05	27
	6	0.26	4.98	27
	7	0.22	2.99	25
	8	0.29	5.55	33
	9	0.41	10.27	30
	10	0.24	1.65	16
	11	0.29	4.29	26
	12	0.60	13.84	21
	13	0.47	8.81	20
	14	0.37	5.09	17
	15	0.22	2.45	32
	16	0.43	14.07	41
	17	0.40	7.39	21
	18	0.50	16.63	33
	19	0.27	1.70	22
	20	0.39	7.38	25
	21	0.36	5.46	15
	22	0.31	0.81	10
	23	0.28	2.20	15
	24	0.35	4.20	23
	25	0.33	5.81	36
	26	0.38	6.03	21
	27	0.63	19.33	33
	28	0.48	14.24	34
	29	0.20	0.90	18
	30	0.35	3.41	19
	31	0.23	0.89	13

La Marina Alta	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.23	0.66	16
	2	0.16	0.02	6
	3	0.41	3.67	20
	4	0.55	15.95	45
	5	0.29	0.69	20
	6	0.36	2.66	24
	7	0.62	9.95	19
	8	0.46	3.65	23
	9	0.33	0.42	23
	10	0.39	0.83	17
	11	0.68	20.62	42
	12	0.45	3.38	42
	13	0.37	0.57	35
	14	0.45	1.74	17
T. erytreae	1	0.19	0.66	16
	2	0.14	0.02	6
	3	0.35	4.04	21
	4	0.36	5.68	39
	5	0.61	12.21	23
	6	0.24	0.69	20
	7	0.29	2.66	24
	8	0.58	9.37	18
	9	0.24	0.42	23
	10	0.30	0.83	17
	11	0.59	22.53	48
	12	0.35	3.38	42
	13	0.27	0.57	35
	14	0.34	1.74	17

La Marina Baixa	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.20	0.82	32
	2	0.37	1.42	16
	3	0.25	0.30	13
	4	0.19	0.41	17
	5	0.37	5.74	36
	6	0.37	3.62	31
	7	0.26	0.83	24
	8	0.48	7.37	24
T. erytreae	1	0.16	0.30	26
	2	0.31	1.42	16
	3	0.20	0.80	17
	4	0.16	0.41	17
	5	0.31	5.09	37
	6	0.25	0.91	15
	7	0.25	2.90	35
	8	0.41	8.68	30

El Baix Vinalopó	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.29	0.55	17
	2	0.38	2.42	19
	3	0.34	1.34	34
	4	0.30	1.20	28
	5	0.35	0.50	18
	6	0.35	0.36	16
	7	0.39	3.73	39
	8	0.33	0.75	29
	9	0.33	0.29	14
	10	0.36	2.51	42
	11	0.37	0.55	23
T. erytreae	1	0.17	0.55	17
	2	0.29	1.82	11
	3	0.20	1.41	35
	4	0.18	1.20	28
	5	0.21	0.84	32
	6	0.22	1.11	23
	7	0.26	3.38	34
	8	0.22	1.17	37
	9	0.26	1.49	26
	10	0.24	0.39	19
	11	0.24	0.84	17

El Vinalopó Medio	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.15	0.01	2
	2	0.24	0.17	21
	3	0.24	0.18	41
T. erytreae	1	0.07	0.01	2
	2	0.13	0.18	25
	3	0.14	0.17	37

4.4 Risk maps and CHMAs for Murcia autonomous community

Risk maps

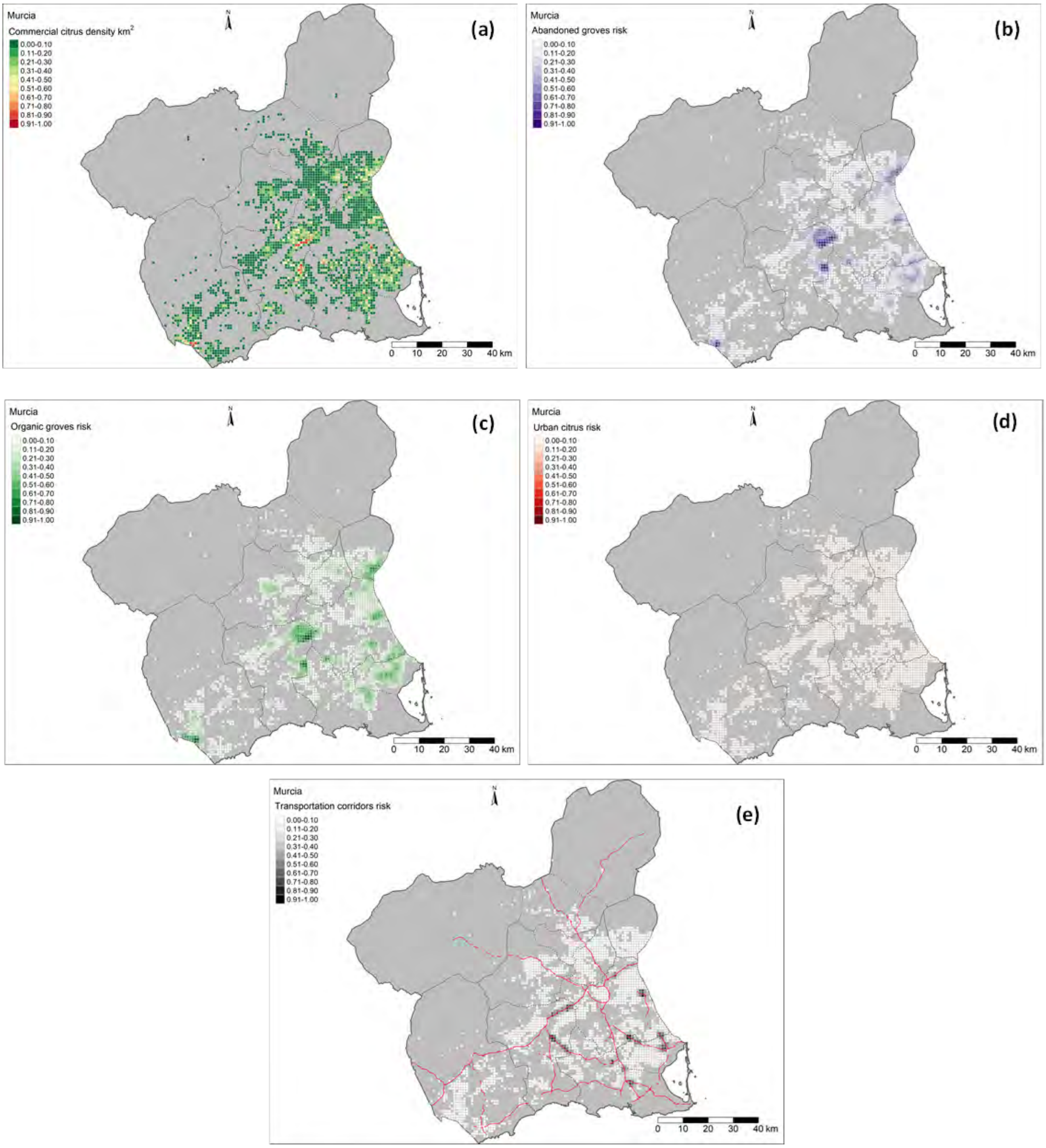

Figure 14. Risk maps for Murcia autonomous community.

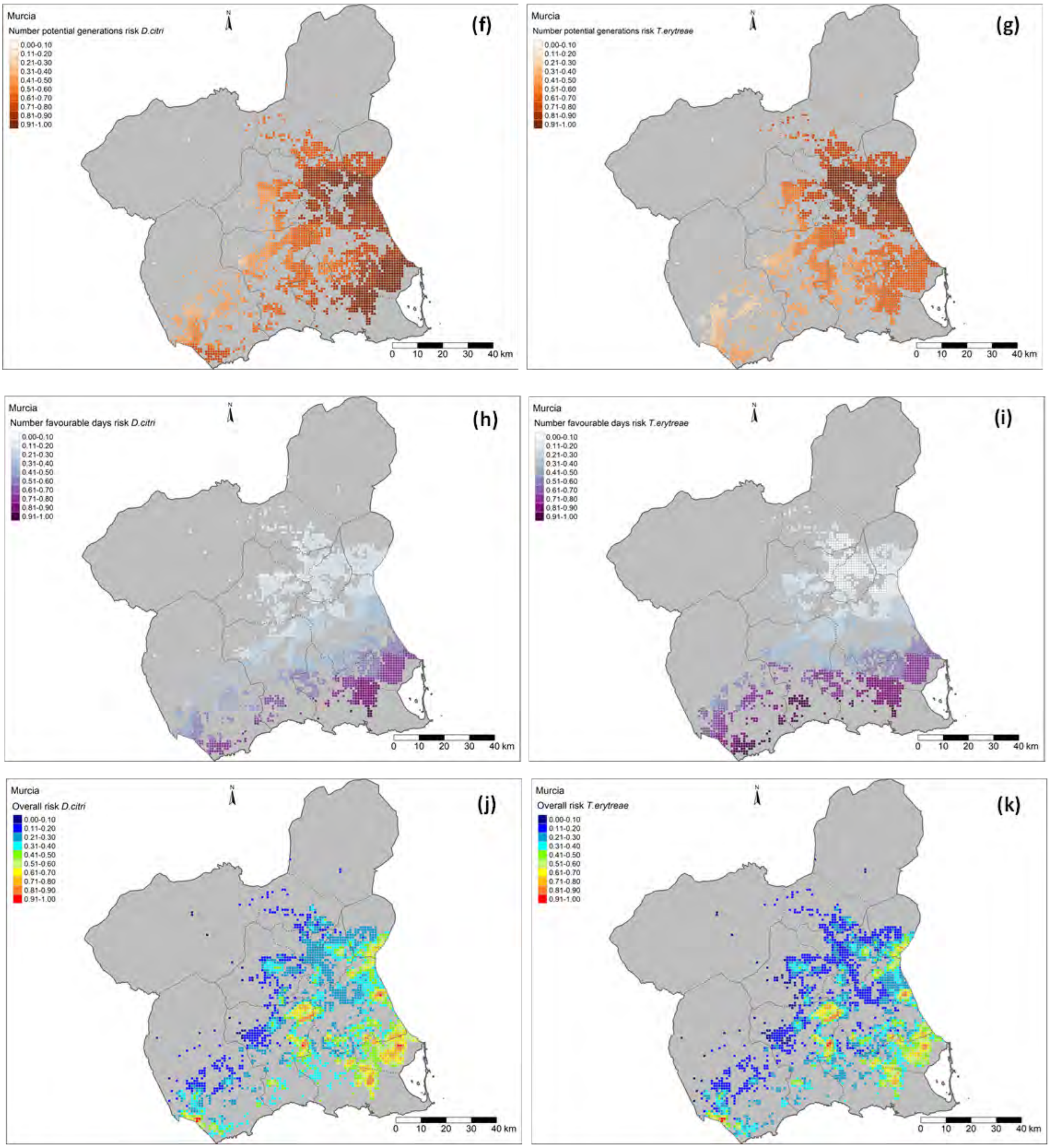

Figure 14. Risk maps for Murcia autonomous community.

CHMAs: graphical and numerical description

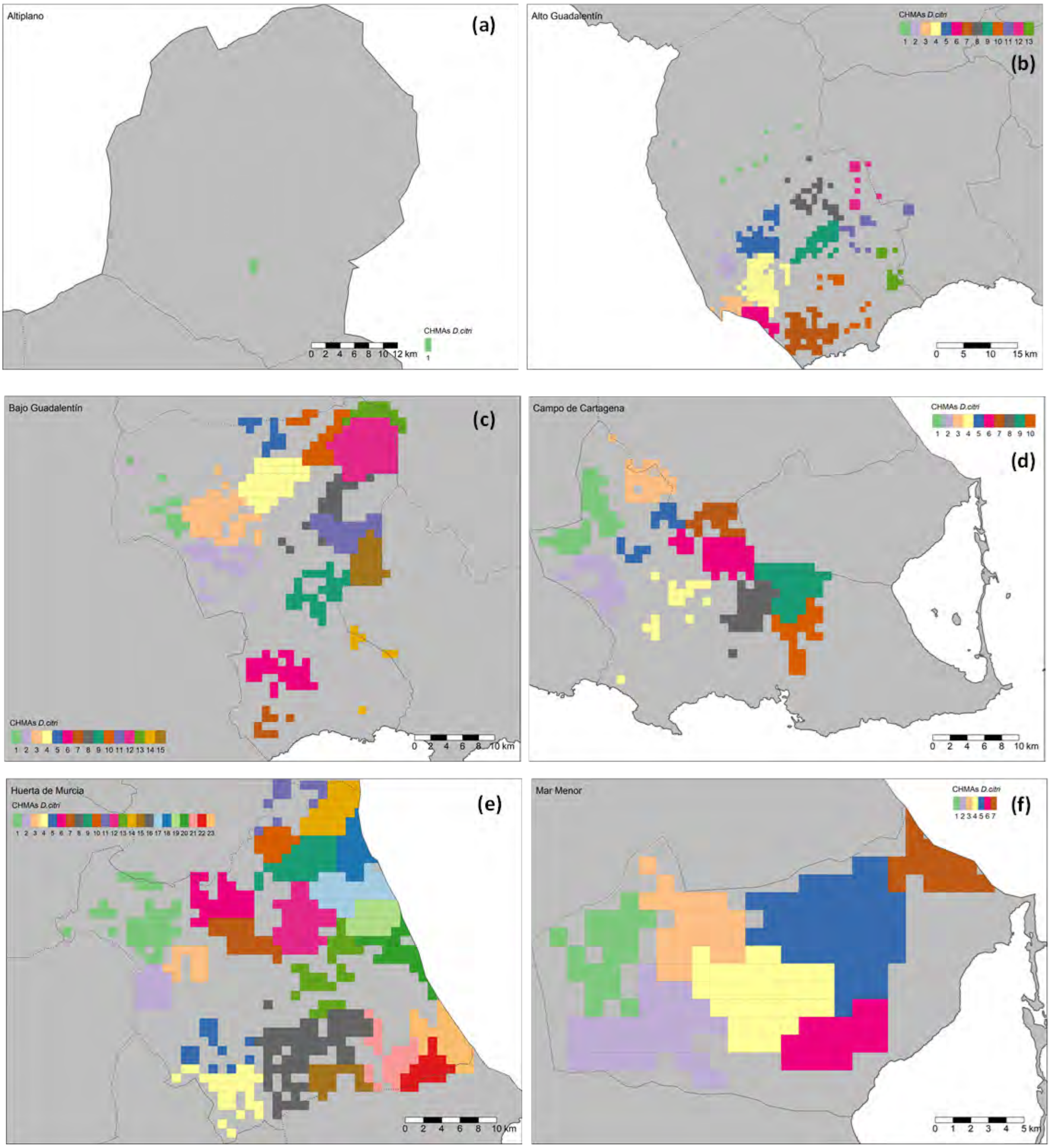

Figure 15. CHMAs for *D. citri* within Murcia autonomous community at comarca level.

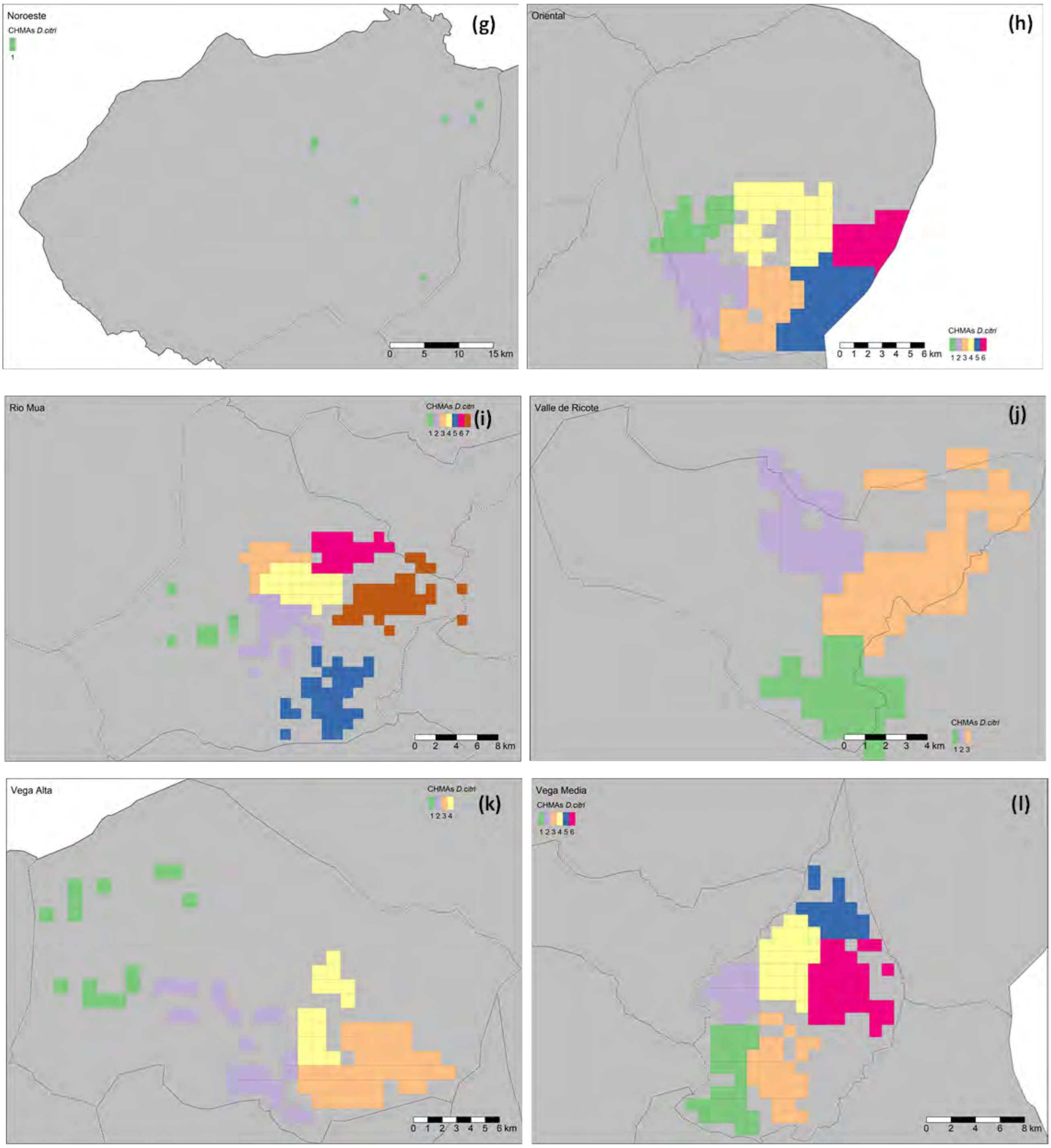

Figure 15. CHMAs for *D. citri* within Murcia autonomous community at comarca level.

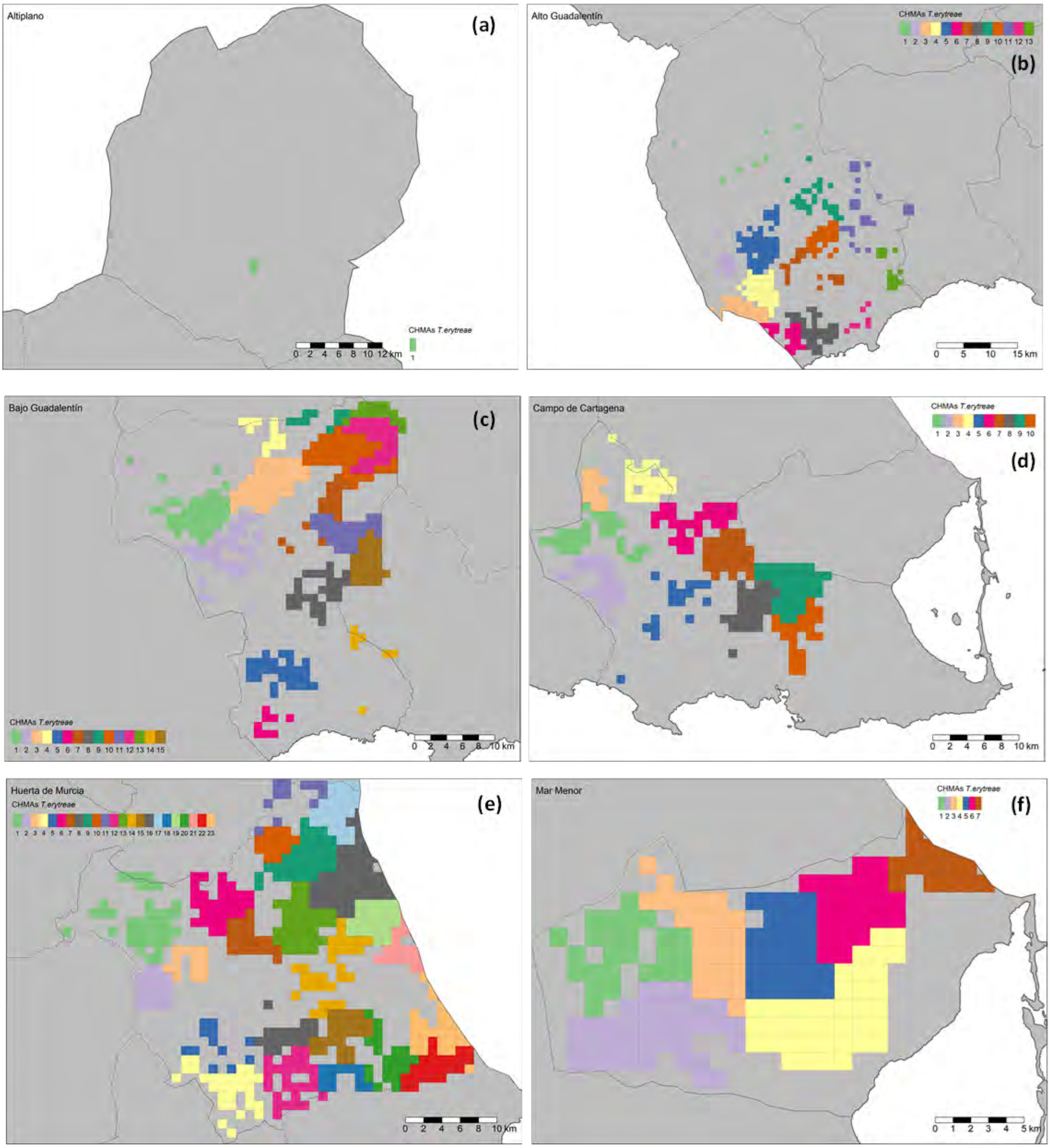

Figure 16. CHMAs for *T. erytreae* within Murcia autonomous community at comarca level.

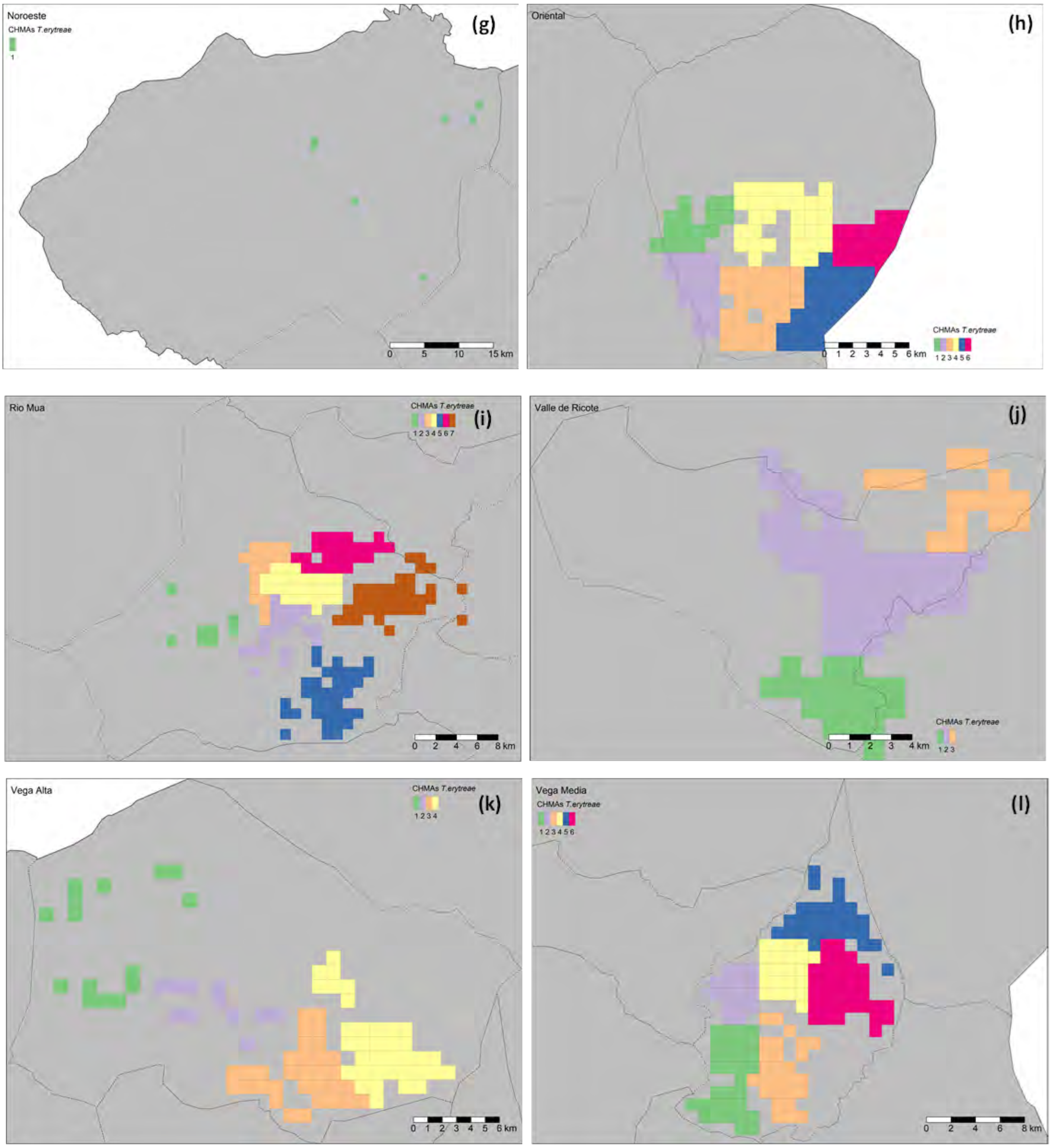

Figure 16. CHMAs for *T. erytreae* within Murcia autonomous community at comarca level.

Altiplano	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1.00	0.13	4.16	3
T. erytreae	1.00	0.13	4.16	3

Alto Guadalentín	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.10	0.00	7
	2	0.24	1.51	18
	3	0.39	3.37	18
	4	0.31	6.11	57
	5	0.17	1.15	39
	6	0.63	7.42	21
	7	0.39	3.94	54
	8	0.17	0.03	27
	9	0.23	1.61	32
	10	0.30	0.12	14
	11	0.23	0.53	16
	12	0.21	0.30	12
	13	0.33	0.87	14
T. erytreae	1	0.08	0.00	7
	2	0.21	1.51	18
	3	0.50	9.59	32
	4	0.28	3.86	38
	5	0.18	3.36	53
	6	0.41	2.91	23
	7	0.18	0.16	18
	8	0.30	2.24	38
	9	0.14	0.03	27
	10	0.22	1.54	26
	11	0.19	0.83	28
	12	0.26	0.06	7
	13	0.30	0.87	14

Bajo Guadalentín	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.10	0.05	12
	2	0.21	0.20	25
	3	0.15	1.07	45
	4	0.27	5.17	41
	5	0.15	0.46	12
	6	0.42	3.81	29
	7	0.34	0.39	8
	8	0.31	1.82	19
	9	0.33	2.79	27
	10	0.38	2.90	22
	11	0.51	5.83	28
	12	0.65	20.45	55
	13	0.39	1.70	14
	14	0.33	0.35	7
	15	0.65	9.69	24
T. erytreae	1	0.10	0.84	41
	2	0.15	0.40	37
	3	0.22	5.25	45
	4	0.11	0.46	12
	5	0.37	3.81	29
	6	0.28	0.39	8
	7	0.26	1.76	17
	8	0.29	2.79	27
	9	0.20	0.45	9
	10	0.50	9.33	42
	11	0.47	5.83	28
	12	0.72	13.63	28
	13	0.34	1.70	14
	14	0.28	0.35	7
	15	0.63	9.69	24

Campo de Cartagena	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.35	3.64	35
	2	0.35	1.99	26
	3	0.35	3.60	23
	4	0.37	0.36	17
	5	0.30	0.92	14
	6	0.54	4.35	32
	7	0.36	1.51	17
	8	0.52	2.25	26
	9	0.69	8.73	37
	10	0.56	2.03	23
T. erytreae	1	0.32	3.17	29
	2	0.29	1.99	26
	3	0.24	0.89	12
	4	0.29	3.60	23
	5	0.28	0.36	17
	6	0.30	2.72	28
	7	0.47	3.65	29
	8	0.42	2.25	26
	9	0.59	8.73	37
	10	0.44	2.03	23

Huerta de Murcia	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.31	3.86	39
	2	0.43	4.53	18
	3	0.27	0.79	14
	4	0.42	5.22	28
	5	0.27	0.76	14
	6	0.26	0.96	27
	7	0.25	0.34	22
	8	0.37	5.17	41
	9	0.32	1.85	30
	10	0.55	3.15	14
	11	0.36	1.24	14
	12	0.29	1.66	36
	13	0.34	2.23	28
	14	0.53	5.90	28
	15	0.64	4.37	16
	16	0.44	5.33	24
	17	0.36	2.64	32
	18	0.38	2.50	23
	19	0.69	6.52	21
	20	0.43	3.29	24
	21	0.41	1.85	23
	22	0.71	5.26	17
	23	0.53	5.60	31
T. erytreae	1	0.25	3.86	39
	2	0.38	4.53	18
	3	0.20	0.79	14
	4	0.37	5.68	30
	5	0.18	0.30	12
	6	0.19	0.98	30
	7	0.17	0.31	19
	8	0.33	2.58	17
	9	0.26	2.47	34
	10	0.49	3.15	14
	11	0.28	1.24	14
	12	0.30	3.08	28
	13	0.21	1.63	35
	14	0.26	2.51	30
	15	0.36	5.33	24
	16	0.28	4.63	53
	17	0.47	5.83	27
	18	0.61	3.87	12
	19	0.62	6.92	23
	20	0.32	1.74	21
	21	0.33	2.27	17
	22	0.62	7.31	23
	23	0.39	4.00	30

Mar Menor	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.40	2.39	19
	2	0.51	3.67	33
	3	0.55	3.92	22
	4	0.68	9.53	33
	5	0.66	8.00	47
	6	0.59	3.28	17
	7	0.55	2.67	15
T. erytreae	1	0.32	3.38	25
	2	0.41	3.87	36
	3	0.52	5.81	24
	4	0.51	6.90	39
	5	0.56	5.48	25
	6	0.64	5.35	22
	7	0.43	2.67	15

Noroeste	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.08	1.65	7
T. erytreae	1	0.08	1.65	7

Oriental	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.23	0.75	15
	2	0.30	2.32	23
	3	0.42	4.11	23
	4	0.23	1.20	32
	5	0.54	8.78	31
	6	0.40	3.33	19
T. erytreae	1	0.16	0.75	15
	2	0.25	1.96	18
	3	0.33	4.82	29
	4	0.16	1.20	32
	5	0.50	8.44	30
	6	0.34	3.33	19

Río Mua	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.10	0.18	8
	2	0.19	1.26	25
	3	0.19	0.58	15
	4	0.35	5.84	27
	5	0.24	4.15	36
	6	0.20	1.31	22
	7	0.23	1.35	36
T. erytreae	1	0.07	0.18	8
	2	0.15	1.15	21
	3	0.15	0.60	17
	4	0.33	5.62	26
	5	0.20	4.15	36
	6	0.17	1.60	25
	7	0.17	1.35	36

Valle de Ricote	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.25	1.13	21
	2	0.22	1.02	19
	3	0.26	2.33	39
T. erytreae	1	0.19	0.98	19
	2	0.20	2.54	45
	3	0.19	0.96	15

Vega Alta	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.16	0.06	15
	2	0.17	0.21	23
	3	0.26	3.58	40
	4	0.23	1.16	16
T. erytreae	1	0.12	0.06	15
	2	0.12	0.04	11
	3	0.17	1.27	32
	4	0.21	3.65	36

Vega media	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.32	2.82	30
	2	0.23	0.34	17
	3	0.26	0.69	29
	4	0.32	2.88	29
	5	0.22	0.76	18
	6	0.40	7.53	36
T. erytreae	1	0.27	2.93	32
	2	0.17	0.34	17
	3	0.18	0.57	27
	4	0.27	2.22	22
	5	0.18	1.68	28
	6	0.35	7.26	33

4.5 Risk maps and CHMAs for Andalucía autonomous community

Risk maps for Almería province

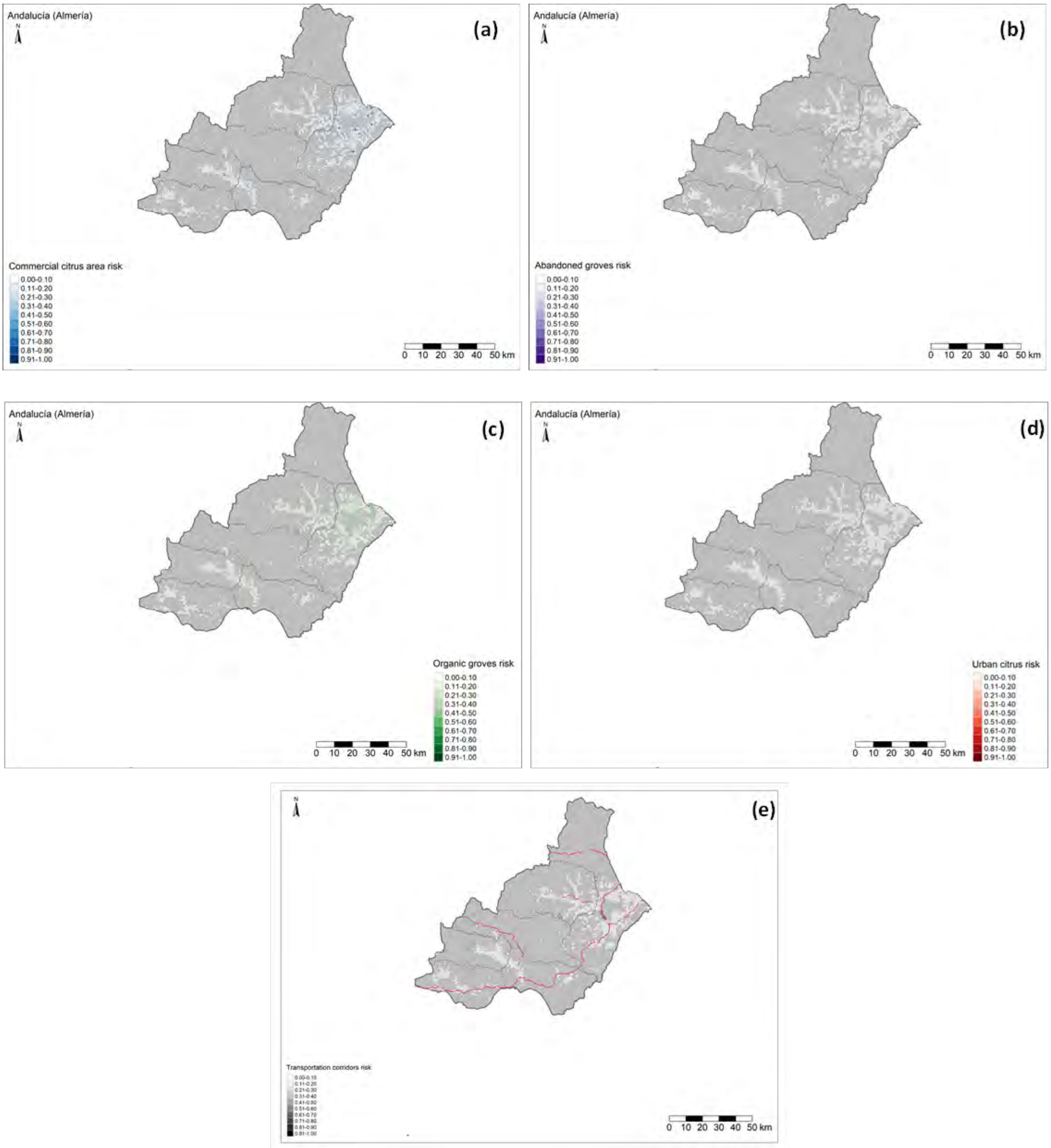

Figure 17. Risk maps for Almería province within Andalucía autonomous community.

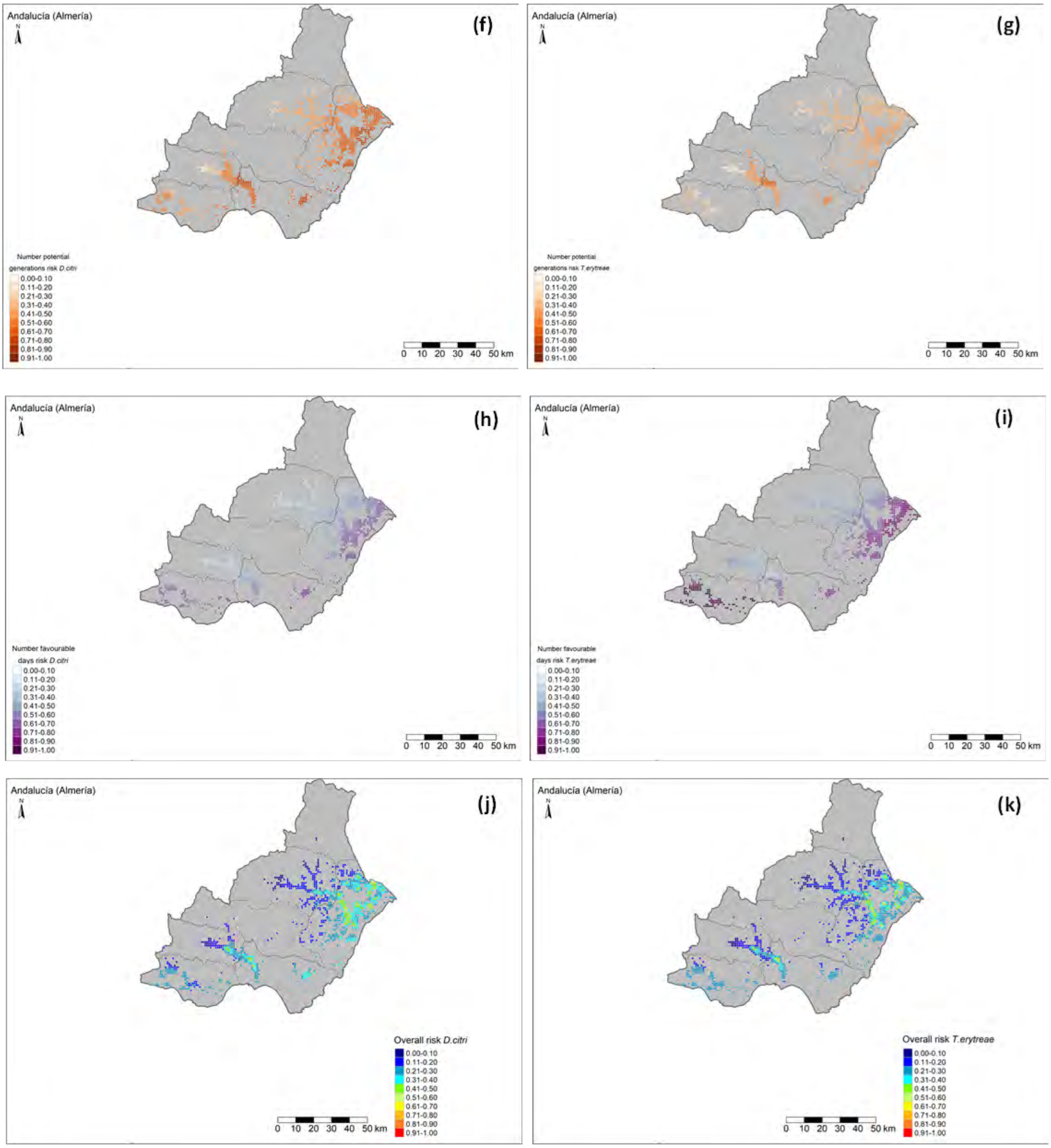

Figure 17. Risk maps for Almería province within Andalucía autonomous community.

CHMAs for Almería province: graphical and numerical description

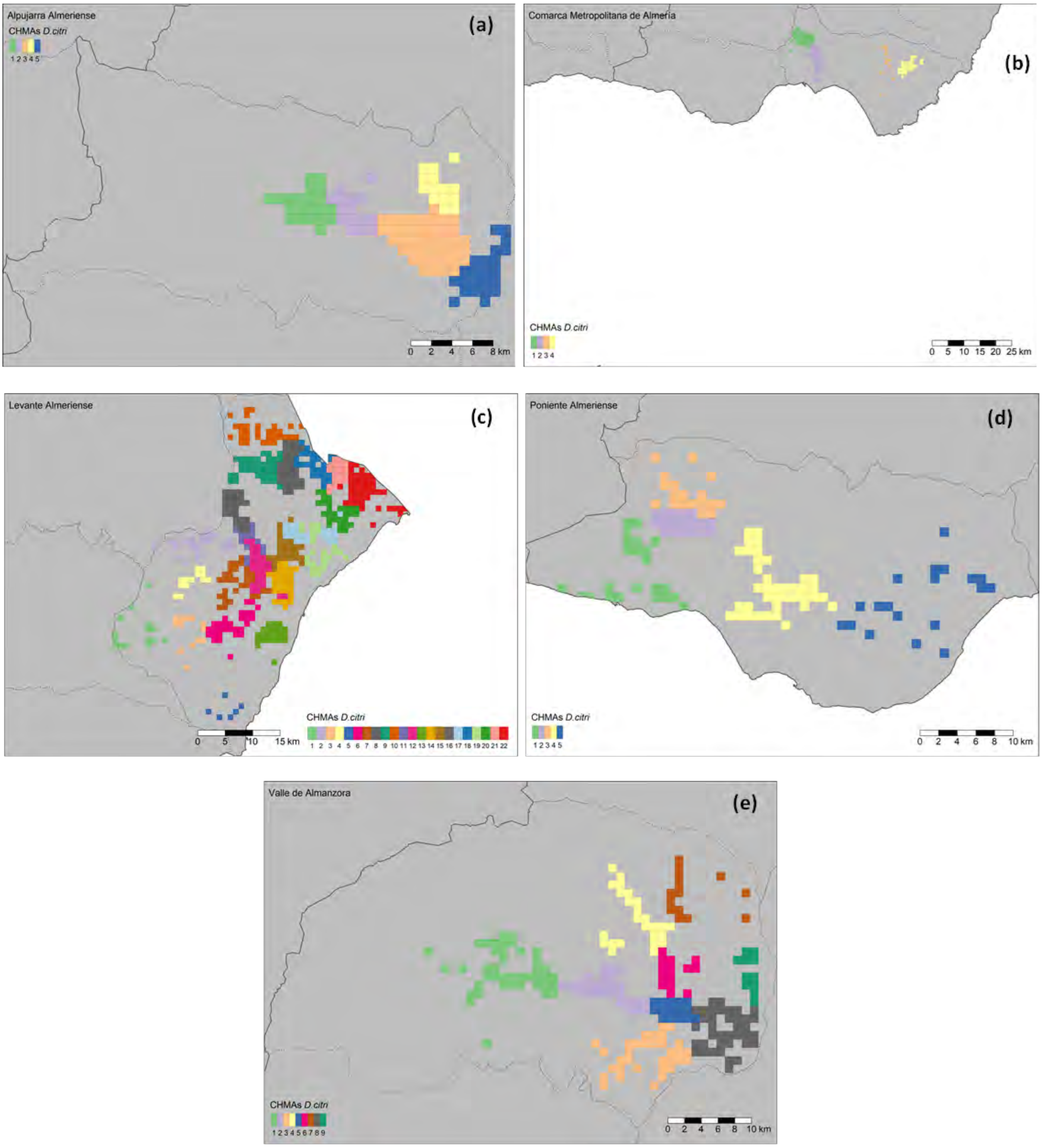

Figure 18. CHMAs for *D. citri* for Almería province within Andalucía autonomous community at comarca level.

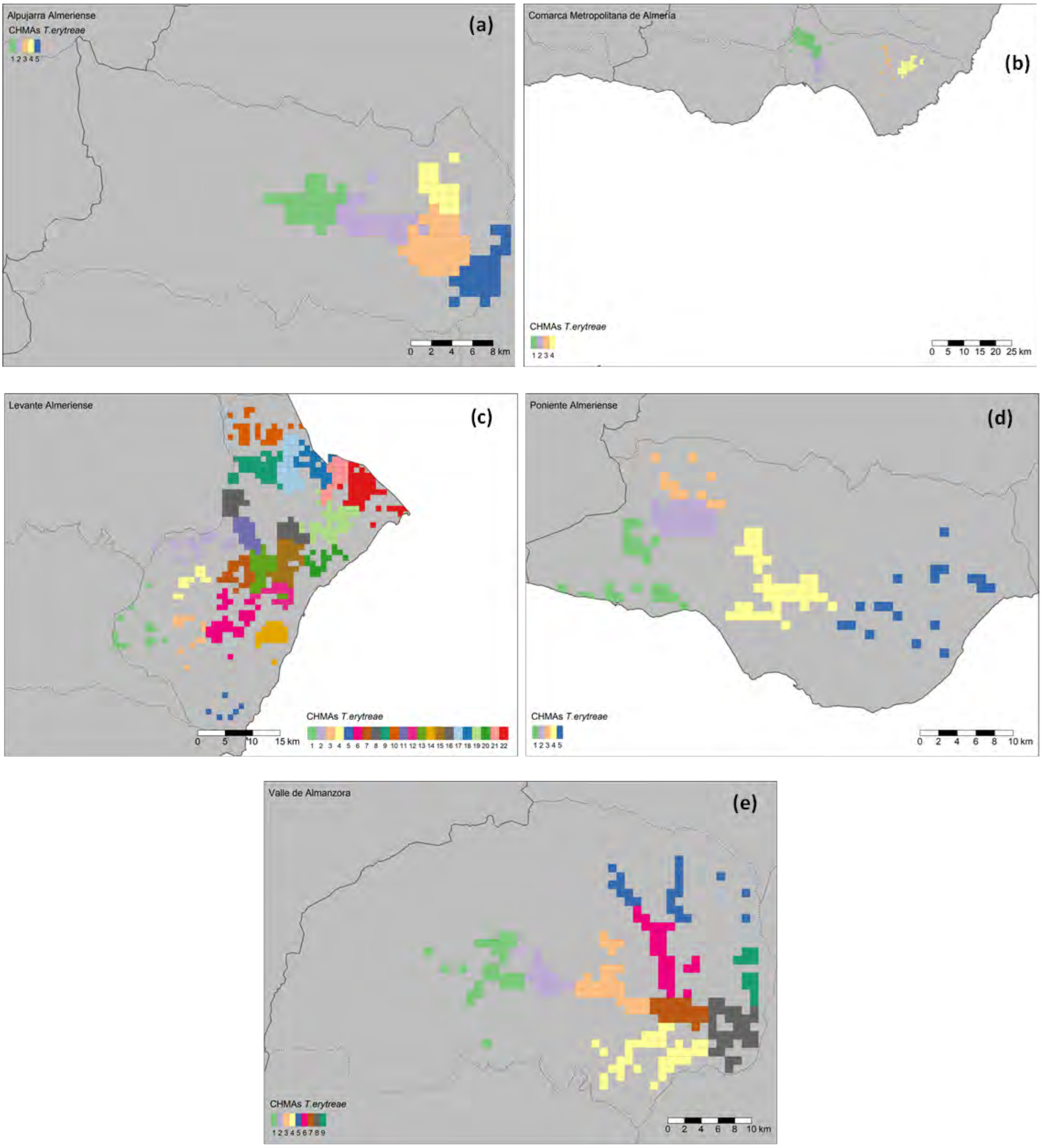

Figure 19. CHMAs for *T. erytreae* for Almería province within Andalucía autonomous community at comarca level.

Alpujarra Almeriense	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.09	0.48	21
	2	0.13	0.51	15
	3	0.28	5.98	42
	4	0.20	0.56	14
	5	0.24	1.46	23
T. erytreae	1	0.09	0.54	24
	2	0.17	1.73	22
	3	0.26	4.70	32
	4	0.16	0.56	14
	5	0.19	1.46	23

Comarca Metropolitana de Almería	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.33	3.91	32
	2	0.30	2.11	32
	3	0.25	0.02	11
	4	0.30	0.17	23
T. erytreae	1	0.30	5.53	46
	2	0.24	0.49	18
	3	0.20	0.02	11
	4	0.23	0.17	23

Levante Almeriense	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.17	0.12	15
	2	0.20	0.60	23
	3	0.21	0.21	13
	4	0.19	0.05	13
	5	0.31	0.01	6
	6	0.28	1.46	30
	7	0.26	0.81	31
	8	0.38	5.27	27
	9	0.27	2.85	37
	10	0.15	0.23	32
	11	0.38	1.76	13
	12	0.48	8.79	28
	13	0.30	0.91	22
	14	0.33	2.84	29
	15	0.34	2.15	26
	16	0.35	6.28	34
	17	0.46	6.59	23
	18	0.28	2.09	28
	19	0.30	0.77	25
	20	0.34	3.24	28
	21	0.47	7.61	20
	22	0.31	3.49	43
T. erytreae	1	0.14	0.12	15
	2	0.15	0.60	23
	3	0.18	0.21	13
	4	0.15	0.05	13
	5	0.24	0.01	6
	6	0.22	1.52	37
	7	0.22	0.99	22
	8	0.31	3.34	19
	9	0.23	2.85	37
	10	0.10	0.15	29
	11	0.43	5.44	22
	12	0.31	2.15	17
	13	0.41	7.03	29
	14	0.25	0.91	22
	15	0.27	2.28	34
	16	0.40	4.46	18
	17	0.32	6.36	37
	18	0.25	2.09	28
	19	0.32	4.72	41
	20	0.24	0.33	17
	21	0.45	9.04	24
	22	0.28	3.49	43

Poniente Almeriense	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.26	0.28	23
	2	0.25	0.30	18
	3	0.15	0.19	18
	4	0.21	0.24	39
	5	0.24	0.17	19
T. erytreae	1	0.24	0.28	23
	2	0.23	0.38	25
	3	0.16	0.11	11
	4	0.22	0.24	39
	5	0.23	0.17	19

Valle Almanzora	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.10	0.64	42
	2	0.17	1.57	27
	3	0.17	0.85	33
	4	0.13	0.17	25
	5	0.31	2.81	15
	6	0.16	0.14	14
	7	0.11	0.01	14
	8	0.25	3.19	38
	9	0.20	0.65	11
T. erytreae	1	0.08	0.50	28
	2	0.10	0.23	16
	3	0.15	1.48	30
	4	0.13	0.96	37
	5	0.07	0.03	22
	6	0.12	0.29	26
	7	0.28	3.01	19
	8	0.22	2.88	30
	9	0.15	0.65	11

Risk maps for Cádiz

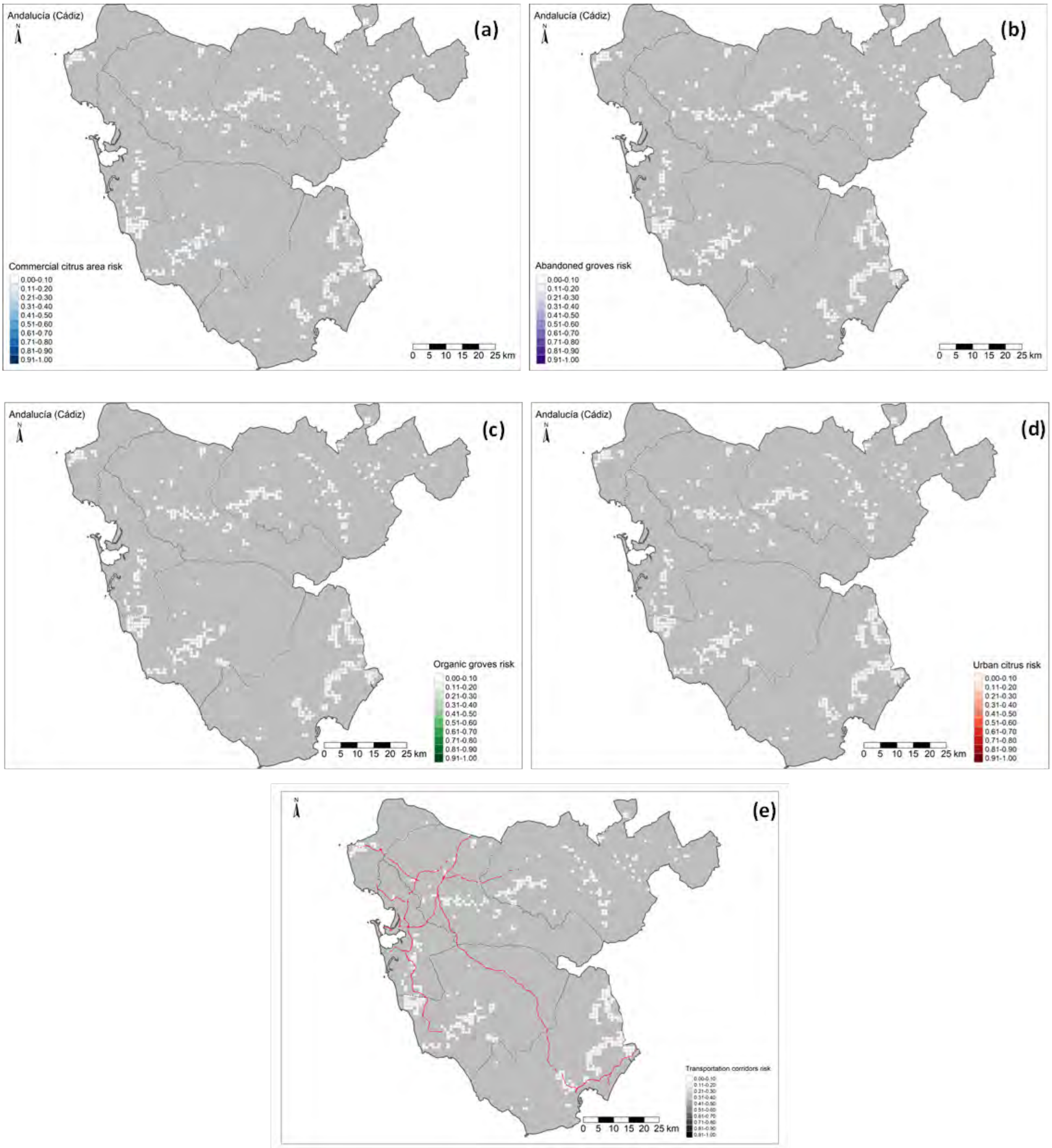

Figure 20. Risk maps for Cádiz province within Andalucía autonomous community.

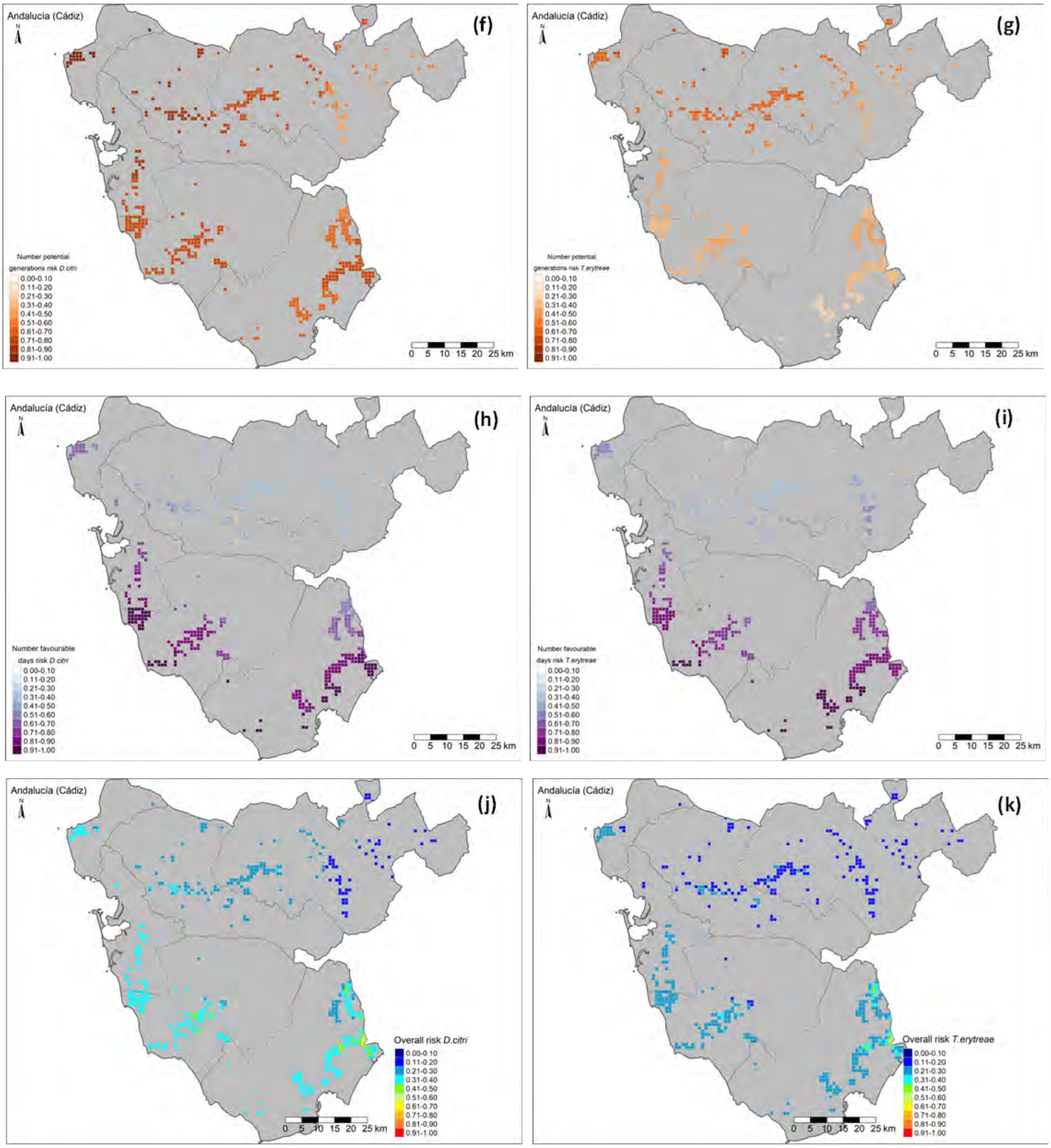

Figure 20. Risk maps for Cádiz province within Andalucía autonomous community.

CHMAs for Cádiz province: graphical and numerical description

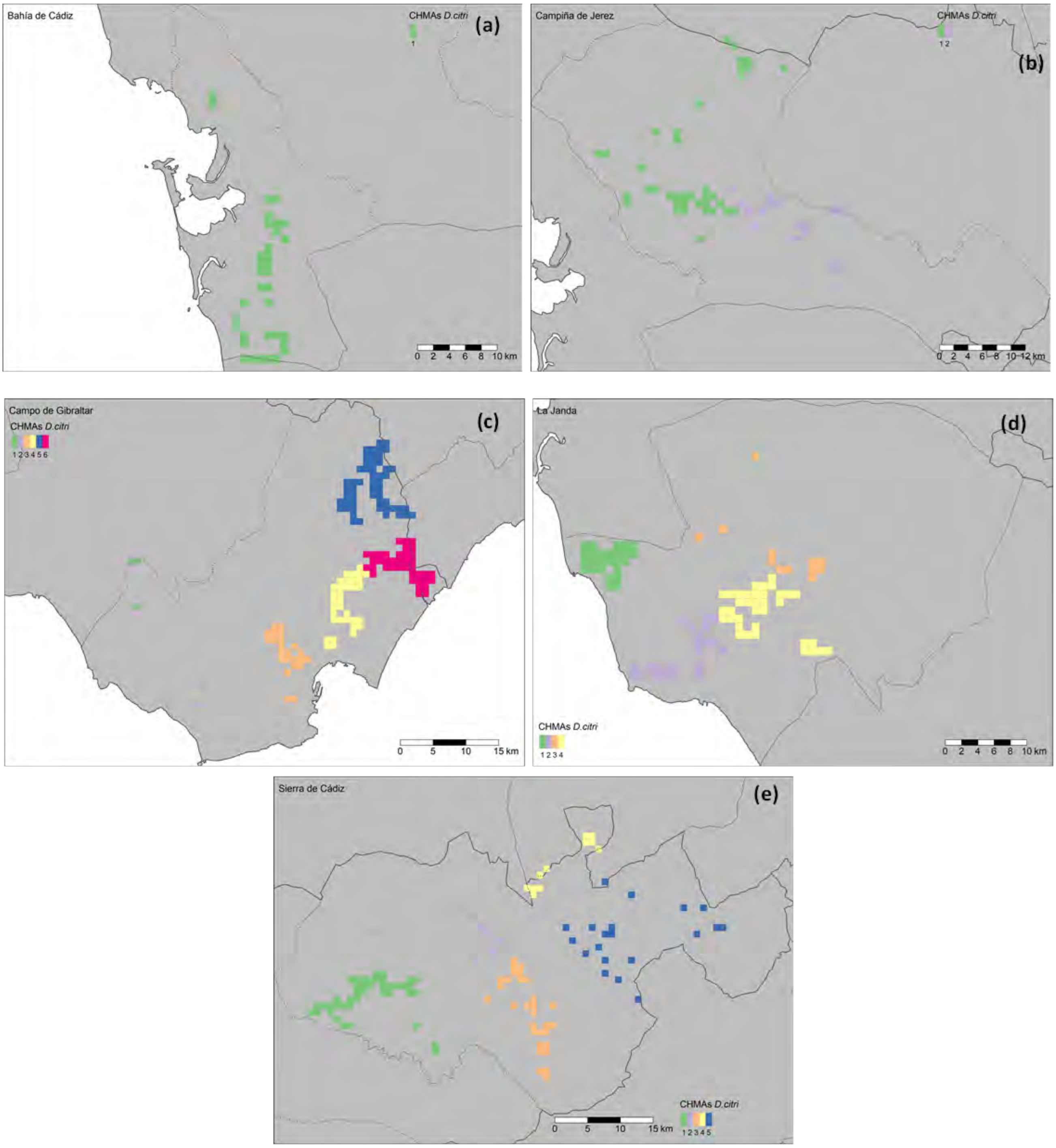

Figure 21. CHMAs for *D. citri* for Cádiz province within Andalucía autonomous community at comarca level.

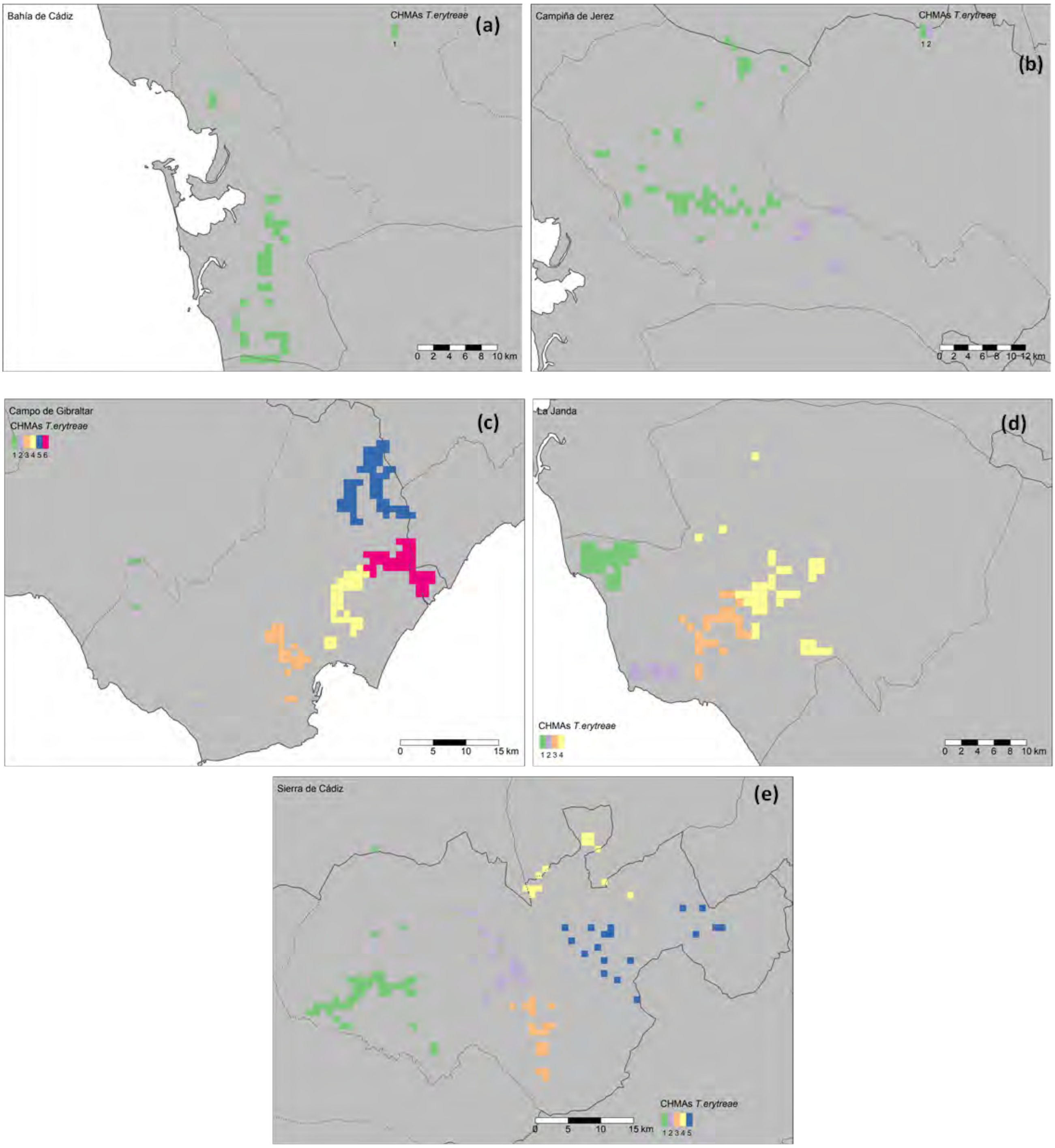

Figure 22. CHMAs for *T. erytreae* for Cádiz province within Andalucía autonomous community at comarca level.

Bahía de Cádiz	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.33	0.24	35
T. erytreae	1	0.21	0.24	35

Campiña de Jerez	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.28	1.27	38
	2	0.25	0.47	19
T. erytreae	1	0.19	1.31	46
	2	0.19	0.44	11

Campo de Gibraltar	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.36	0.36	3
	2	0.33	0.02	4
	3	0.32	0.68	23
	4	0.37	3.75	34
	5	0.32	5.54	53
	6	0.41	5.60	39
T. erytreae	1	0.26	0.36	3
	2	0.21	0.02	4
	3	0.23	0.68	23
	4	0.28	3.75	34
	5	0.27	5.54	53
	6	0.33	5.60	39

La Janda	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.36	0.26	26
	2	0.35	0.10	22
	3	0.30	0.06	12
	4	0.36	3.02	36
T. erytreae	1	0.23	0.26	26
	2	0.23	0.03	9
	3	0.23	0.25	24
	4	0.24	2.90	37

Sierra de Cádiz	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.24	1.30	42
2	2	0.22	0.03	12
3	3	0.18	0.16	30
4	4	0.20	0.06	11
5	5	0.17	0.14	20
T. erytreae	1	0.18	1.30	45
	2	0.16	0.05	20
	3	0.15	0.14	19
	4	0.15	0.09	13
	5	0.15	0.11	18

Risk maps for Córdoba province

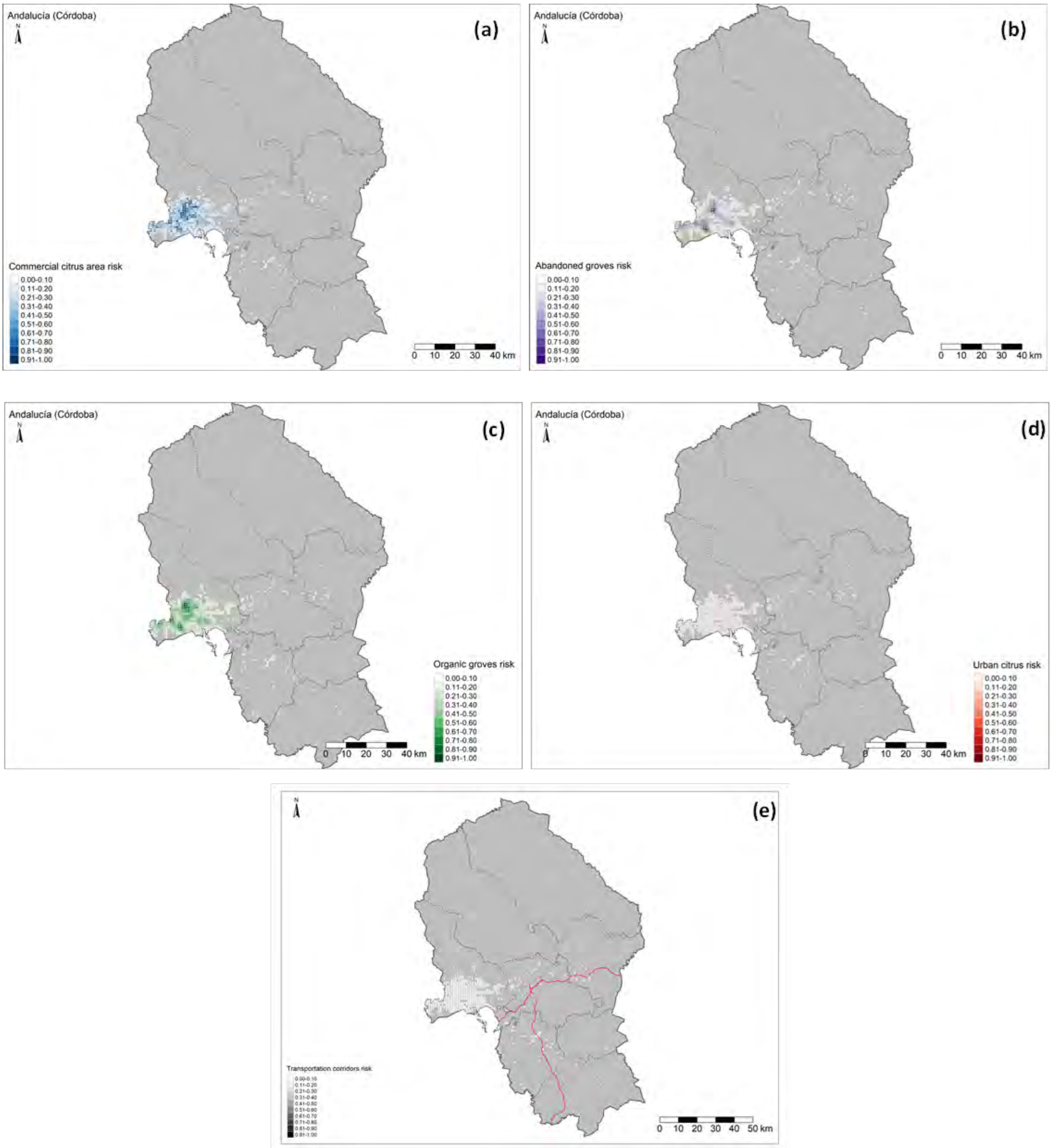

Figure 23. Risk maps for Córdoba province within Andalucía autonomus community.

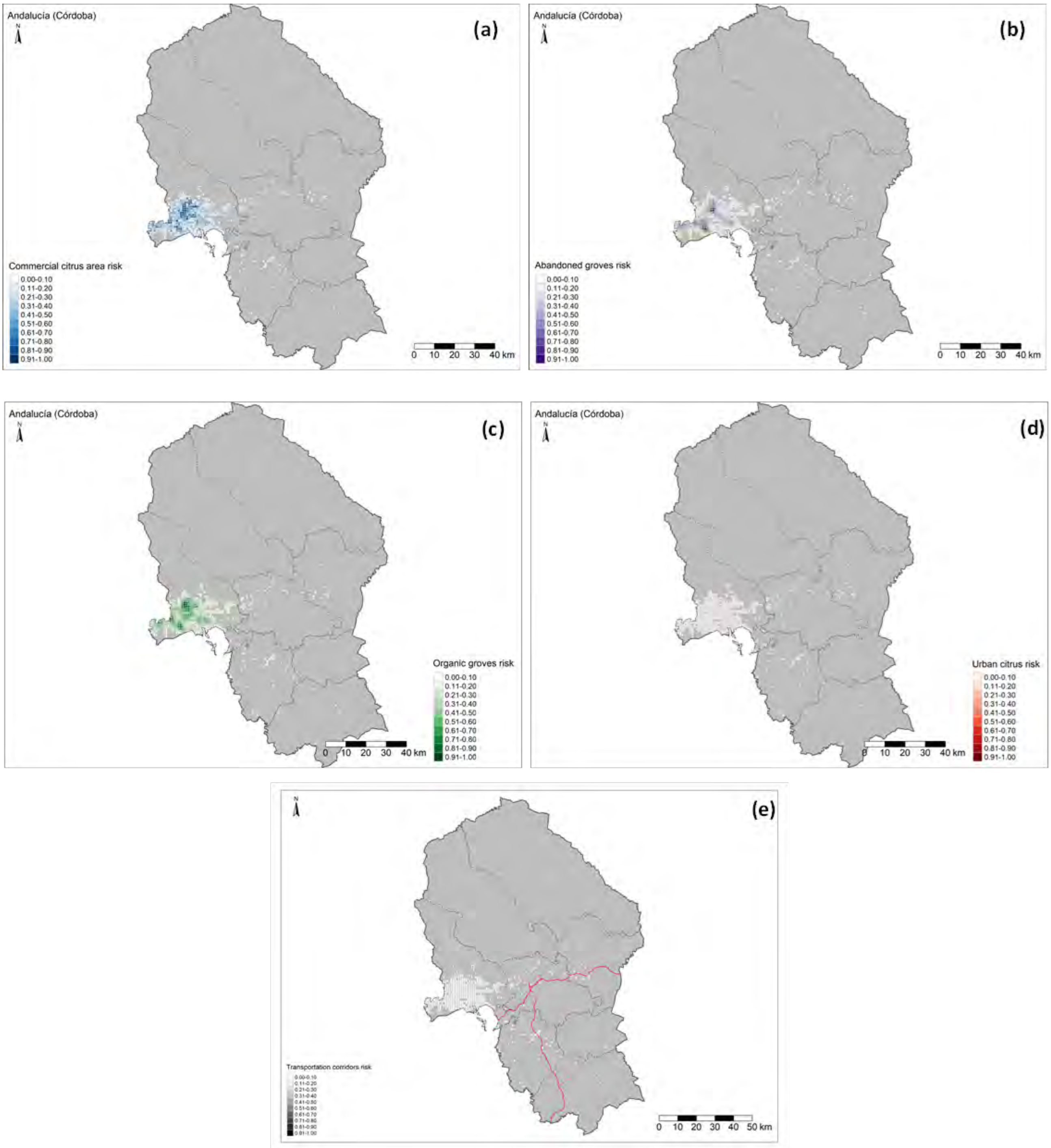

Figure 23. Risk maps for Córdoba province within Andalucía autonomus community.

CHMAs for Córdoba province: graphical and numerical description

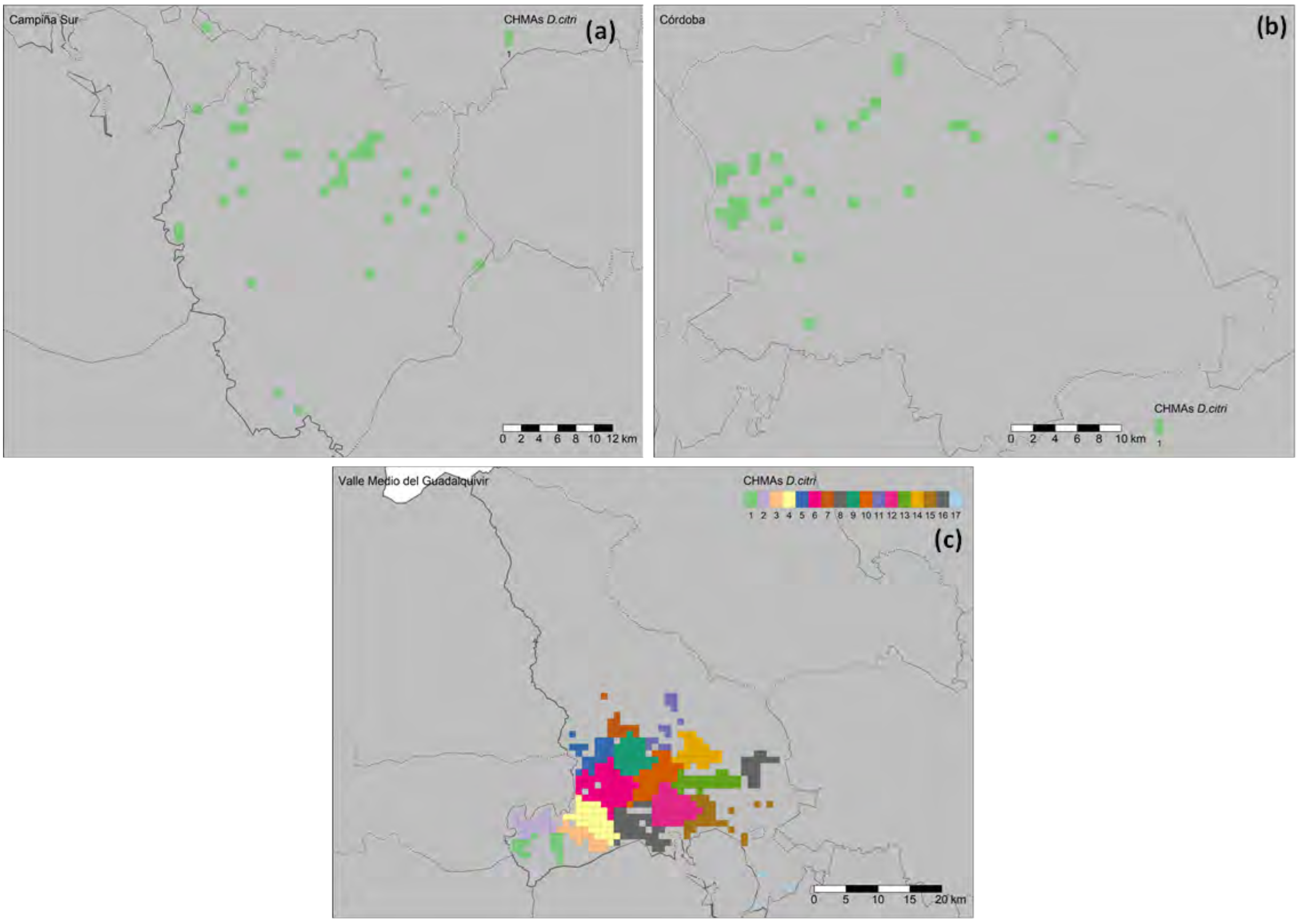

Figure 24. CHMAs for *D. citri* for Córdoba province within Andalucía autonomous community at comarca level.

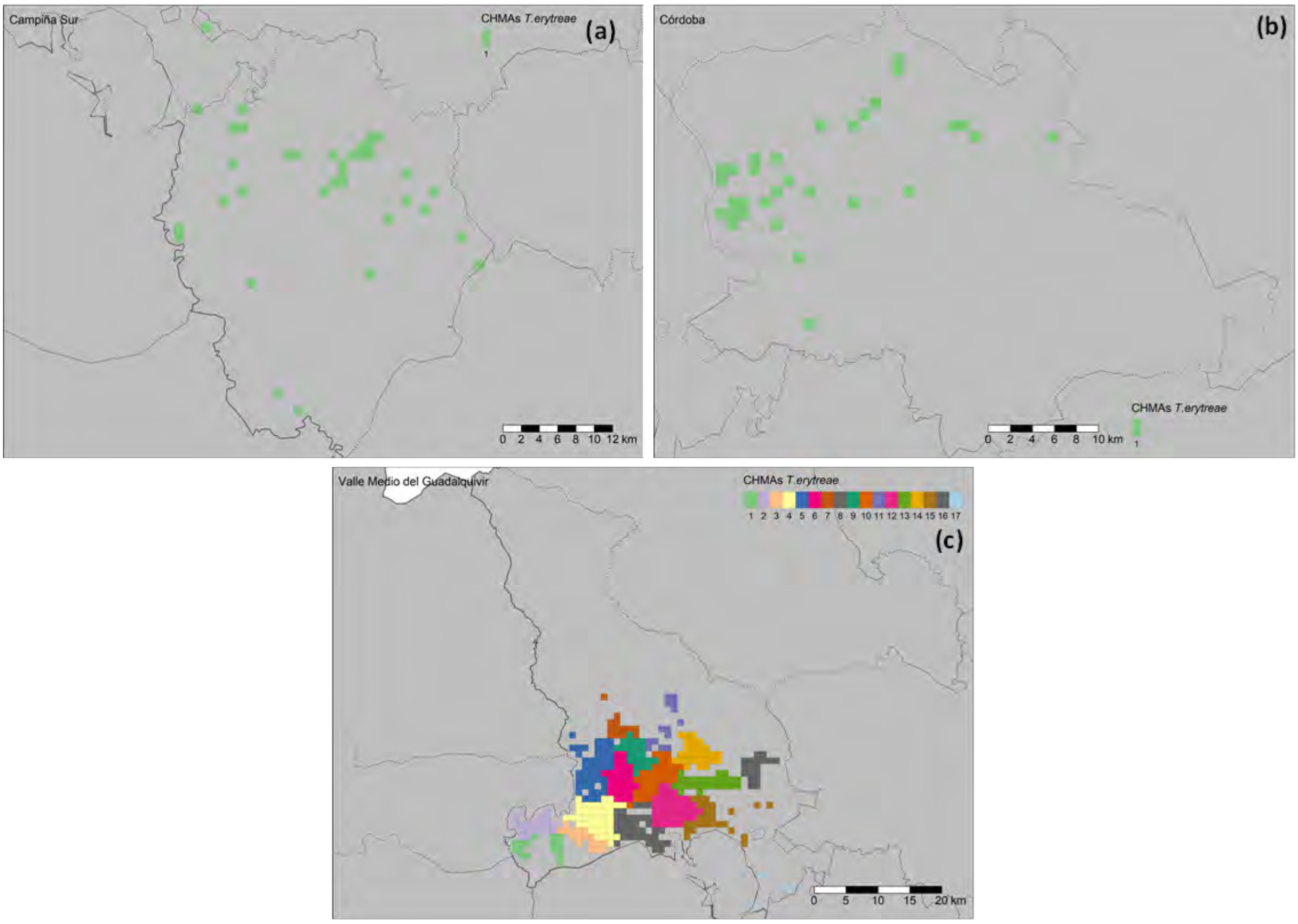

Figure 25. CHMAs for *T. erytreae* for Córdoba province within Andalucía autonomous community at comarca level.

Campiña Sur	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.18	0.31	36
T. erytreae	1	0.15	0.31	36

Córdoba	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.20	1.32	31
T. erytreae	1	0.17	1.32	31

Valle Medio Guadalquivir	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.26	1.34	16
	2	0.45	6.74	20
	3	0.31	2.45	17
	4	0.54	14.59	32
	5	0.31	4.49	22
	6	0.47	22.71	49
	7	0.25	0.56	13
	8	0.27	3.74	36
	9	0.58	19.46	31
	10	0.41	12.34	34
	11	0.23	1.10	14
	12	0.42	13.31	38
	13	0.27	4.34	26
	14	0.26	2.85	28
	15	0.25	1.93	27
	16	0.25	2.20	18
	17	0.18	0.01	4
T. erytreae	1	0.22	1.34	16
	2	0.45	6.74	20
	3	0.29	2.45	17
	4	0.53	17.04	40
	5	0.35	11.99	44
	6	0.62	19.82	28
	7	0.22	0.56	13
	8	0.25	3.74	36
	9	0.54	12.40	22
	10	0.40	12.34	34
	11	0.20	1.10	14
	12	0.42	13.31	38
	13	0.25	4.34	26
	14	0.23	2.85	28
	15	0.22	1.93	27
	16	0.22	2.20	18
	17	0.15	0.01	4

Risk maps for Granada province

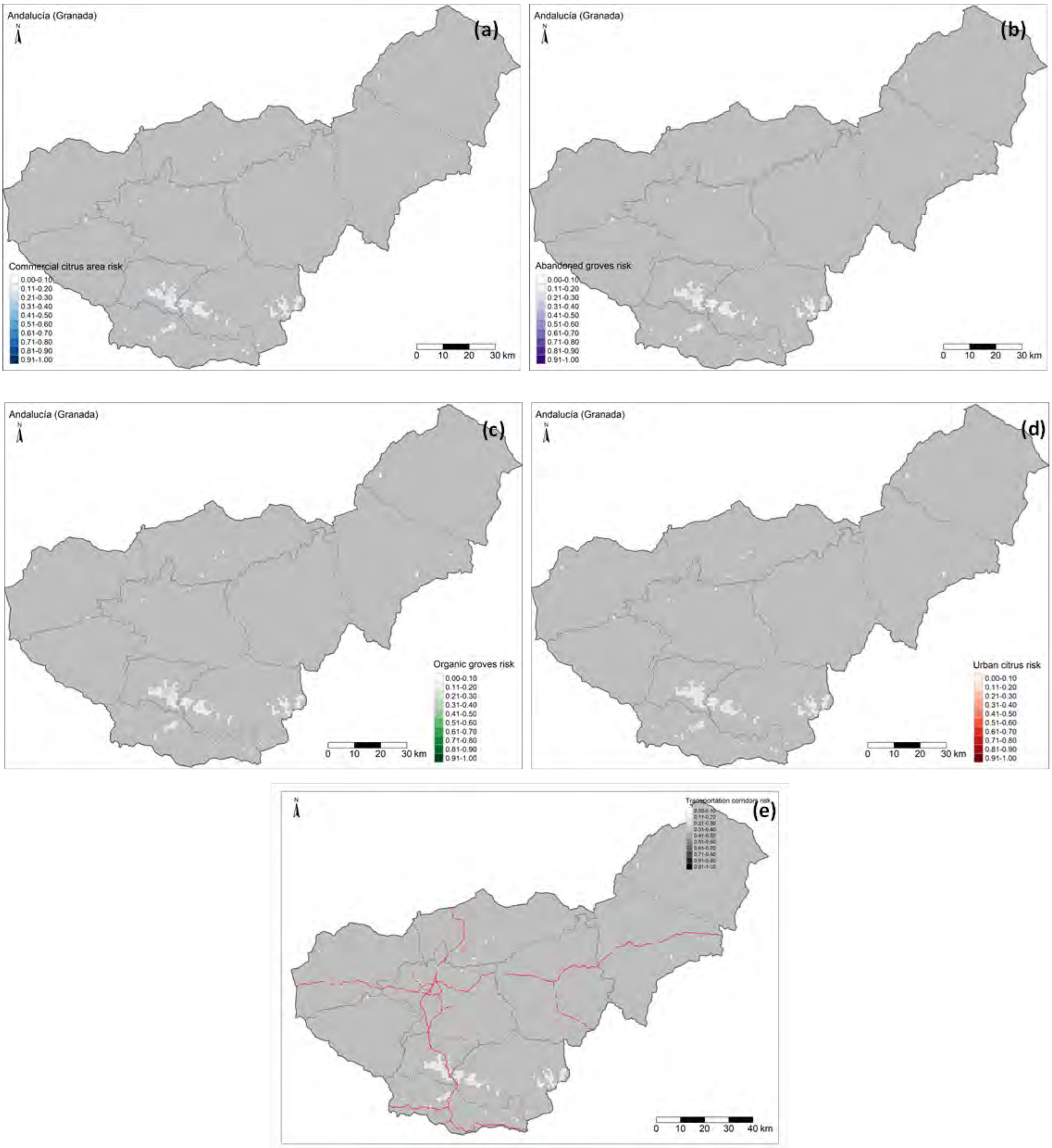

Figure 26. Risk maps for Granada province within Andalucía autonomus community.

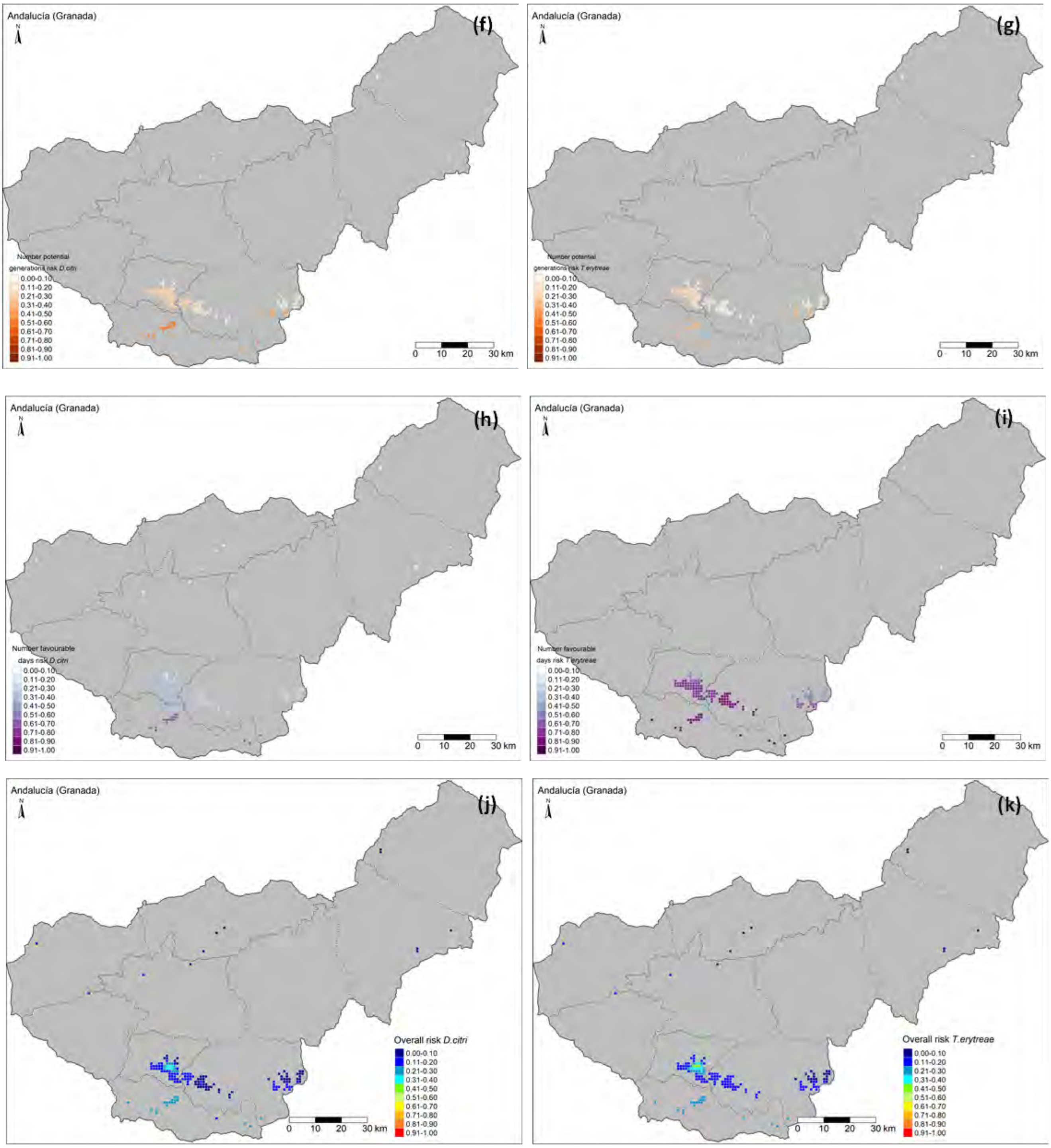

Figure 26. Risk maps for Granada province within Andalucía autonomus community.

CHMAs for Granada province: graphical and numerical description

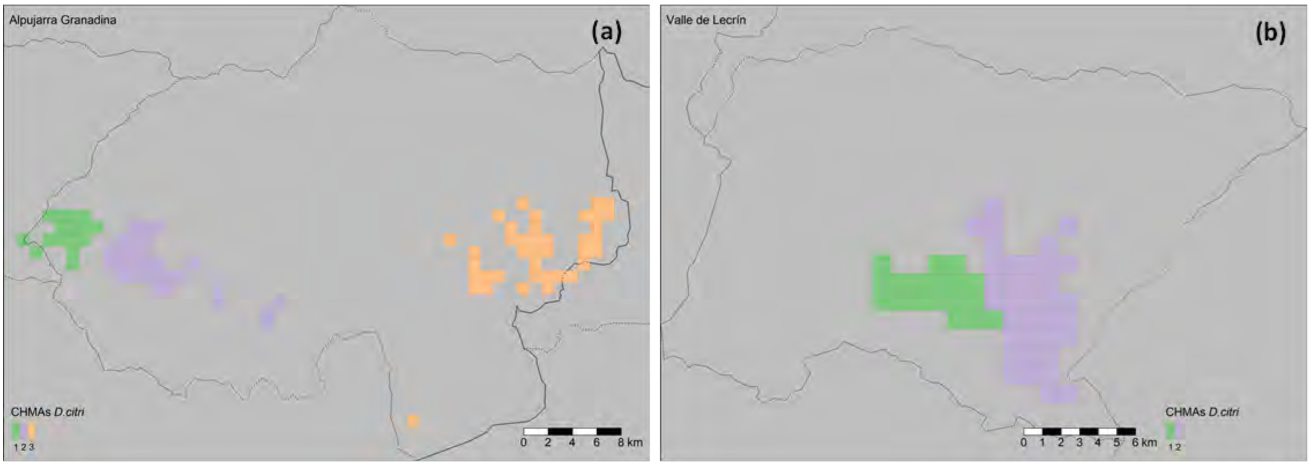

Figure 27. CHMAs for *D. citri* within Granada province at comarca level.

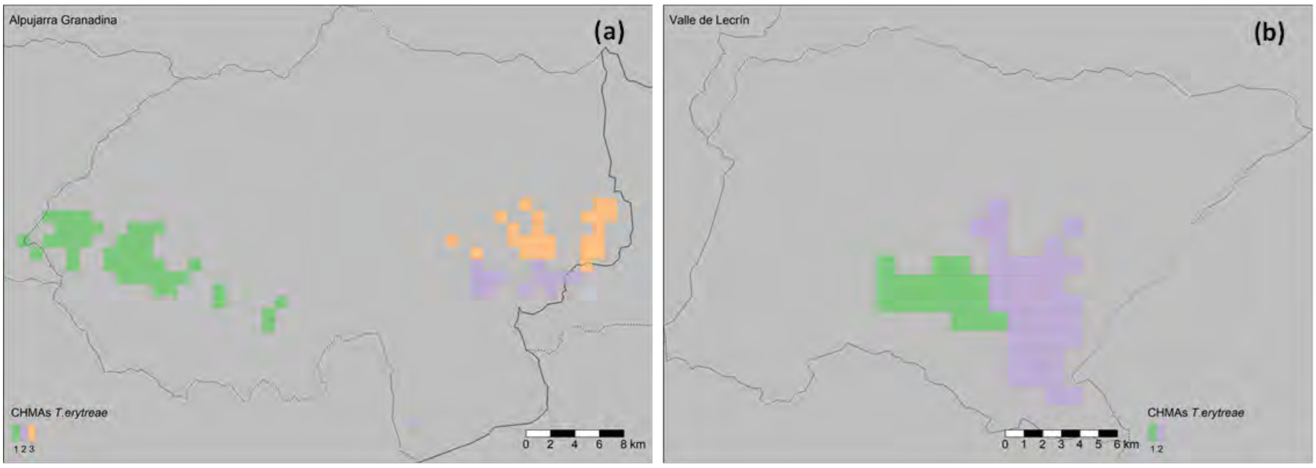

Figure 28. CHMAs for *T. erytreae* within Granada province at comarca level.

Alpujarra Granadina	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.11	0.07	16
	2	0.08	0.39	29
	3	0.12	0.42	39
T. erytreae	1	0.16	0.46	45
	2	0.18	0.07	14
	3	0.09	0.35	25

Valle Lecrín	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.15	0.68	18
	2	0.19	3.26	36
T. erytreae	1	0.19	0.68	18
	2	0.24	3.26	36

Risk maps for Huelva province

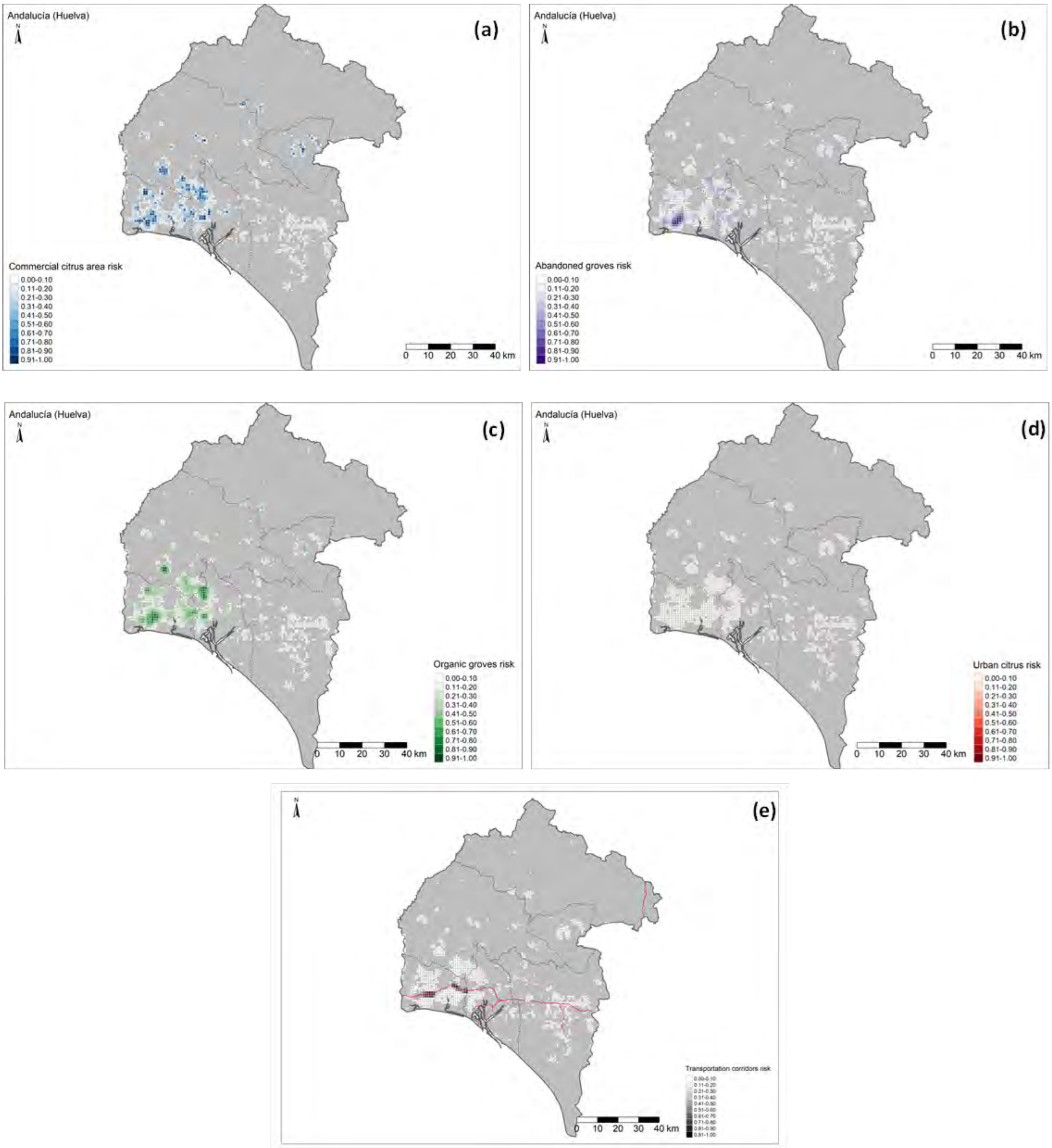

Figure 29. Risk maps for Huelva province within Andalucía autonomus community.

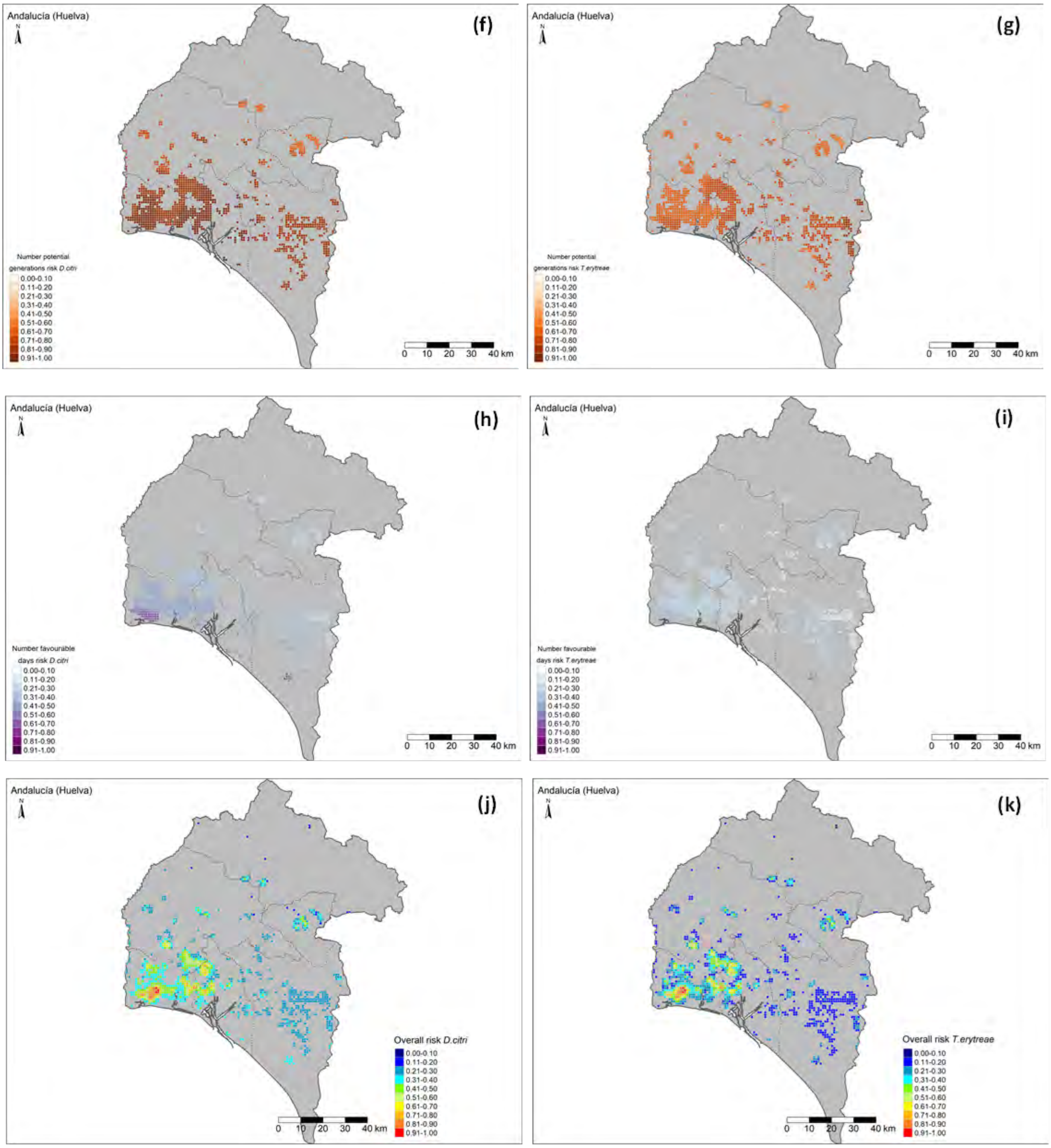

Figure 29. Risk maps for Granada province within Andalucía autonomus community.

CHMAs for Huelva province: graphical and numerical description

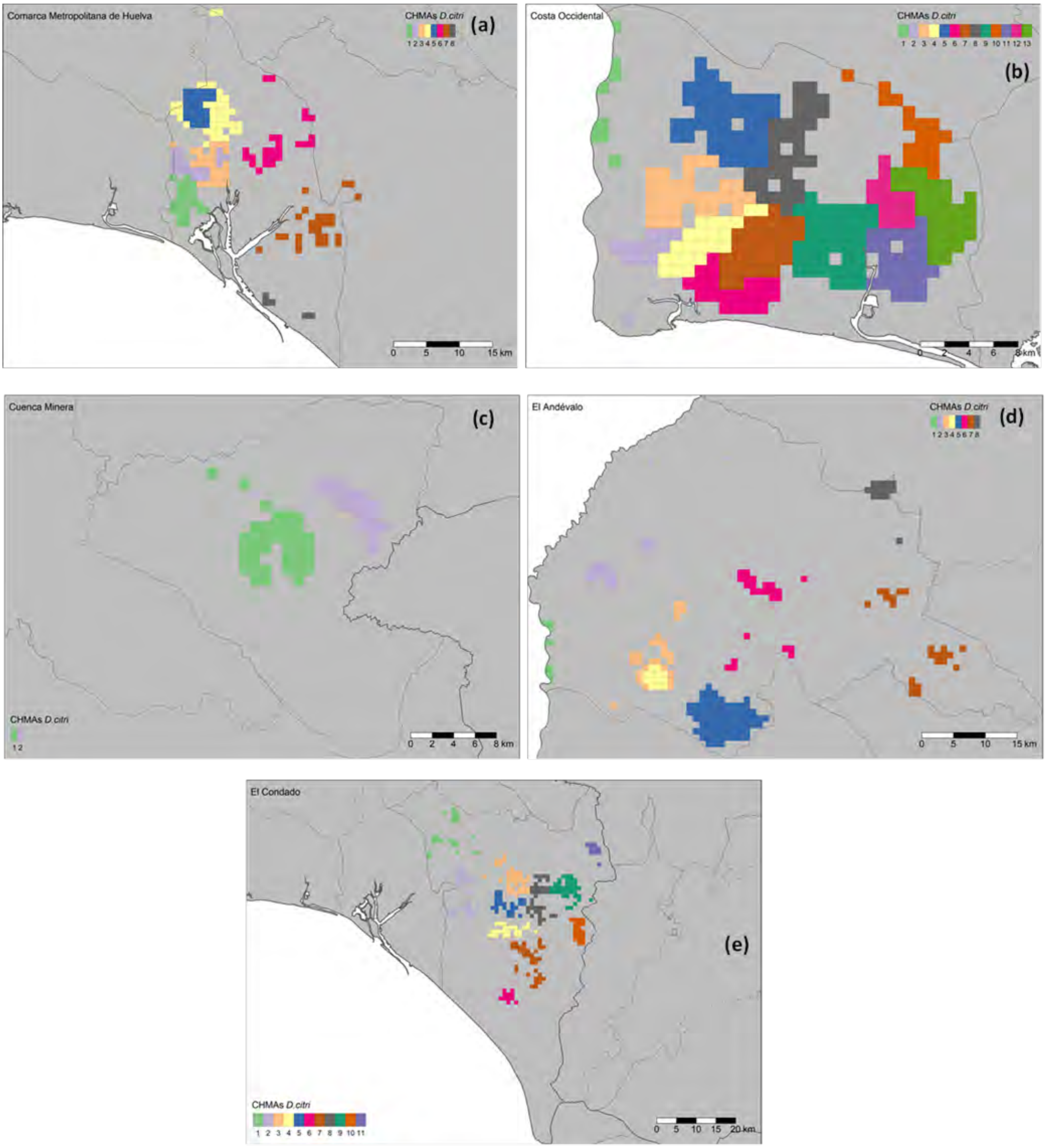

Figure 30. CHMAs for *D. citri* within Huelva province at comarca level.

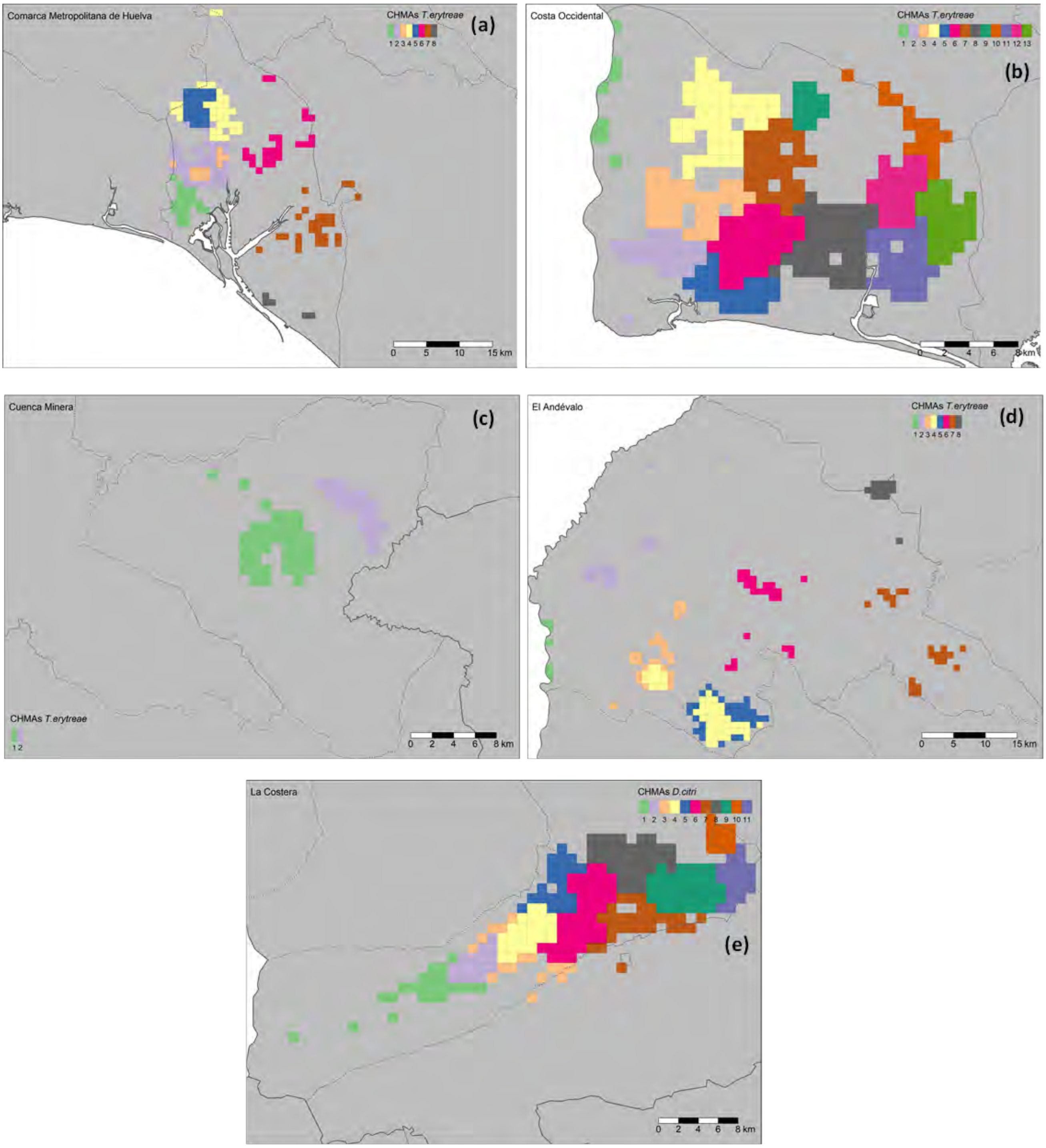

Figure 31. CHMAs for *T. erytreae* within Huelva province at comarca level.

Comarca Metropolitana Huelva	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.35	3.06	25
	2	0.61	11.10	20
	3	0.40	3.34	27
	4	0.34	3.63	39
	5	0.60	13.78	24
	6	0.32	3.00	25
	7	0.30	0.94	27
	8	0.34	0.84	5
T. erytreae	1	0.23	2.62	22
	2	0.34	6.52	43
	3	0.65	8.79	11
	4	0.25	3.19	35
	5	0.56	13.78	24
	6	0.23	3.00	25
	7	0.19	0.94	27
	8	0.23	0.84	5

Costa Occidental	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.28	0.27	9
	2	0.39	1.35	12
	3	0.38	5.15	30
	4	0.62	9.60	22
	5	0.41	12.78	45
	6	0.44	2.85	20
	7	0.75	16.12	30
	8	0.37	6.16	34
	9	0.41	7.12	39
	10	0.34	2.07	18
	11	0.36	3.15	27
	12	0.37	1.47	14
	13	0.59	10.63	30
T. erytreae	1	0.17	0.27	9
	2	0.42	6.60	22
	3	0.29	5.43	31
	4	0.31	11.66	43
	5	0.32	2.85	20
	6	0.70	19.31	35
	7	0.26	4.96	30
	8	0.32	7.63	41
	9	0.29	2.70	10
	10	0.23	1.78	16
	11	0.26	3.15	27
	12	0.35	3.70	22
	13	0.53	8.69	24

Cuenca Minera	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.32	10.16	38
	2	0.26	4.25	18
T. erytreae	1	0.29	10.16	38
	2	0.22	4.25	18

El Andévalo	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.24	0.05	10
	2	0.26	2.20	20
	3	0.28	2.69	28
	4	0.54	8.93	13
	5	0.43	20.27	72
	6	0.32	4.60	24
	7	0.22	0.53	23
	8	0.28	3.23	13
T. erytreae	1	0.15	0.05	10
	2	0.18	2.20	20
	3	0.20	2.69	28
	4	0.47	26.58	53
	5	0.24	2.61	32
	6	0.25	4.60	24
	7	0.16	0.53	23
	8	0.24	3.23	13

El Condado	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.25	1.18	23
	2	0.29	1.79	26
	3	0.26	1.25	39
	4	0.27	1.12	25
	5	0.25	0.04	25
	6	0.32	0.47	11
	7	0.27	1.07	35
	8	0.24	0.14	35
	9	0.24	0.46	36
	10	0.27	1.21	20
	11	0.28	1.34	10
T. erytreae	1	0.17	1.18	23
	2	0.17	0.17	14
	3	0.22	1.64	13
	4	0.17	1.07	43
	5	0.18	1.24	38
	6	0.19	0.94	24
	7	0.18	0.64	25
	8	0.17	0.20	39
	9	0.17	0.47	37
	10	0.21	1.20	19
	11	0.22	1.34	10

Risk maps for Málaga province

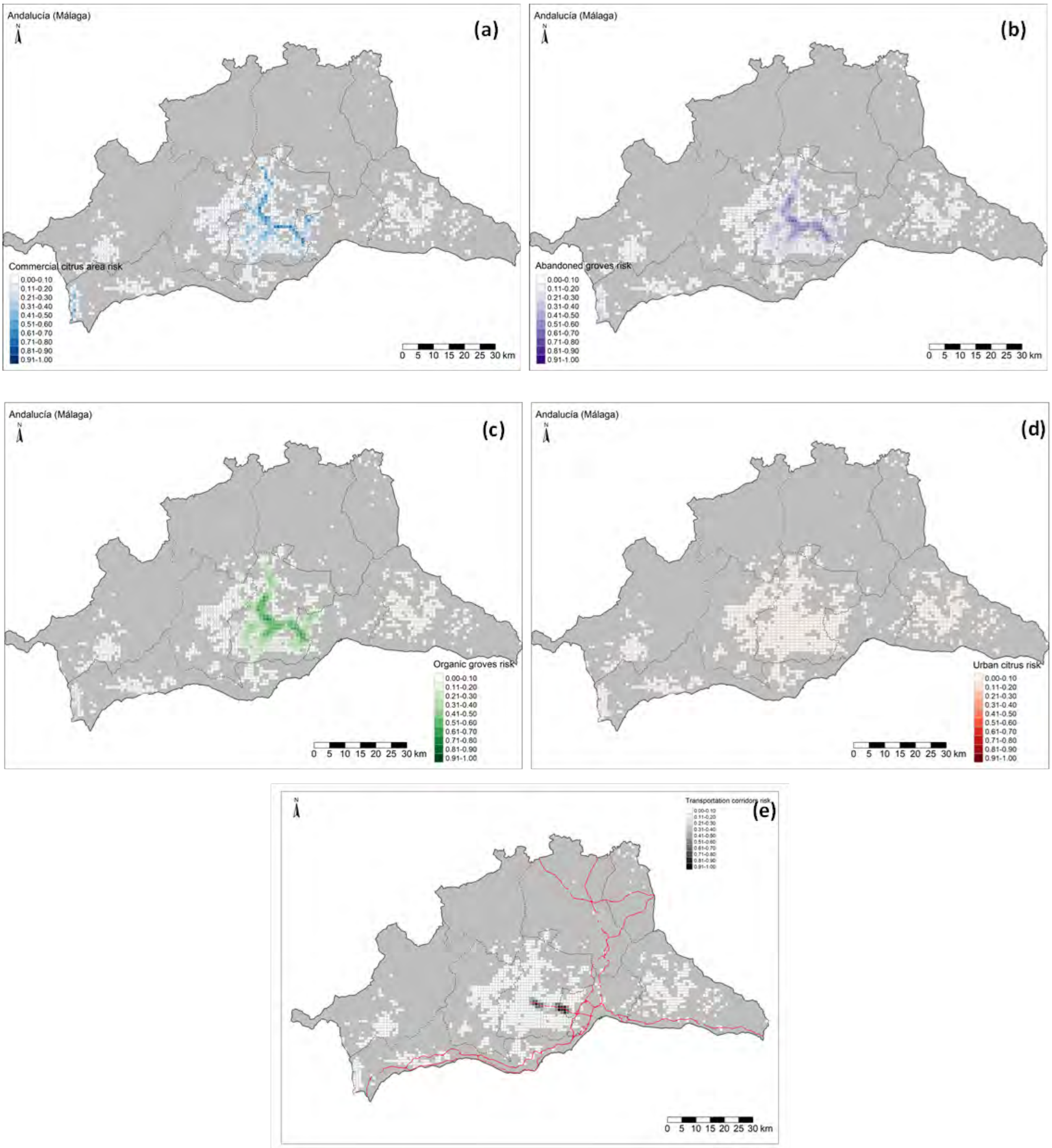

Figure 32. Risk maps for Málaga province within Andalucía autonomus community.

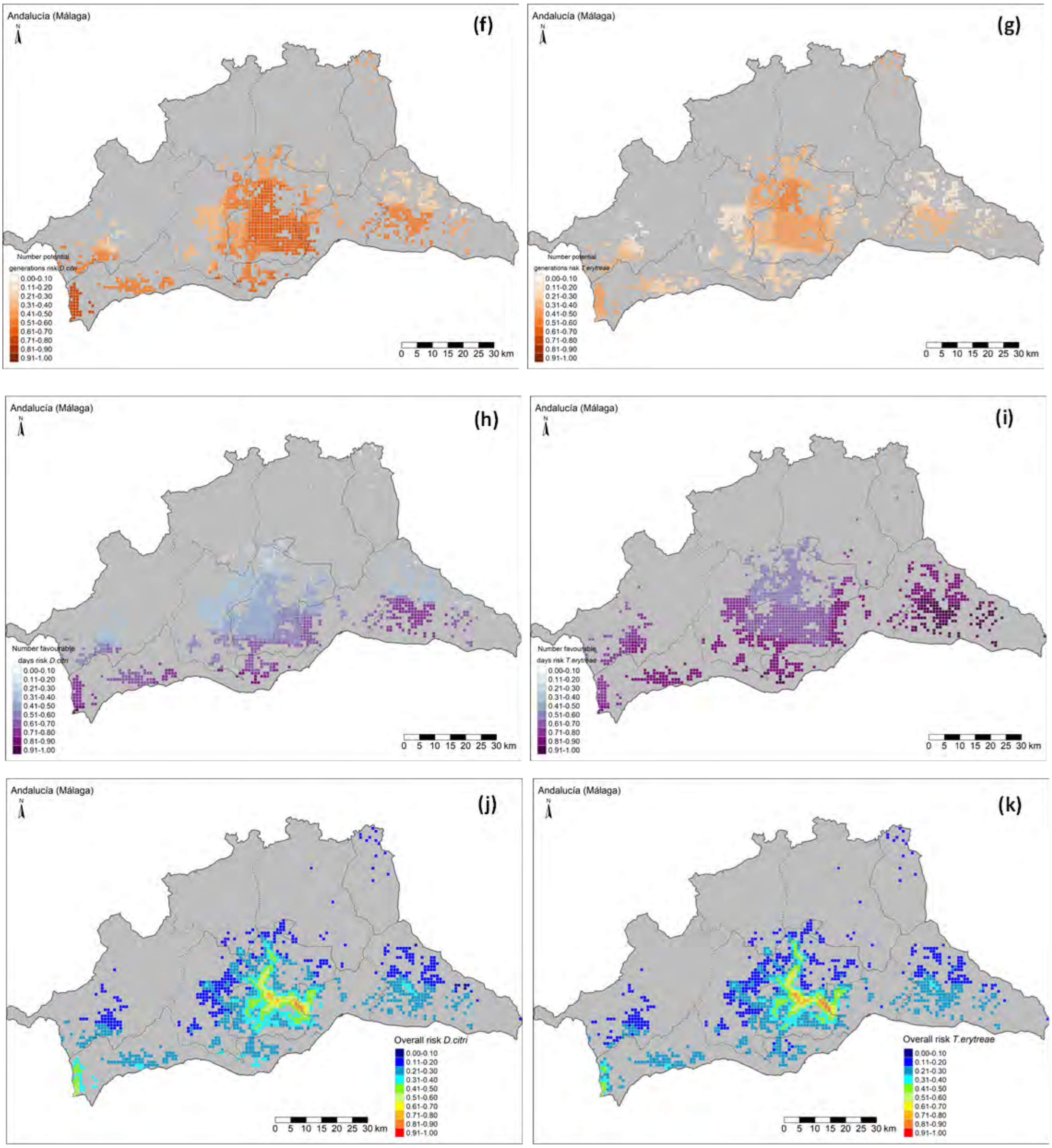

Figure 32. Risk maps for Málaga province within Andalucía autonomus community.

CHMAs for Málaga province: graphical and numerical description

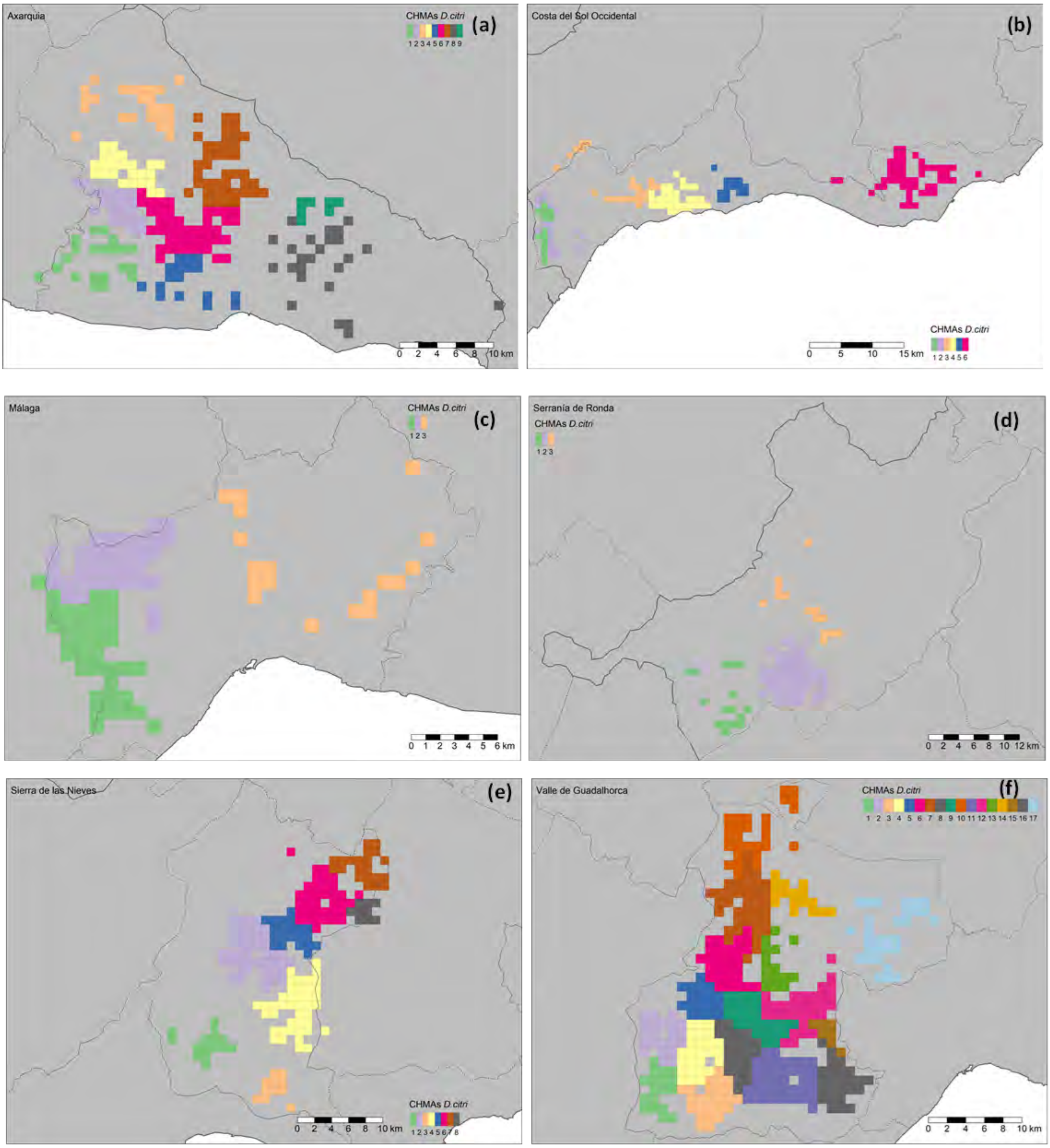

Figure 33. CHMAs for *D. citri* within Málaga province at comarca level.

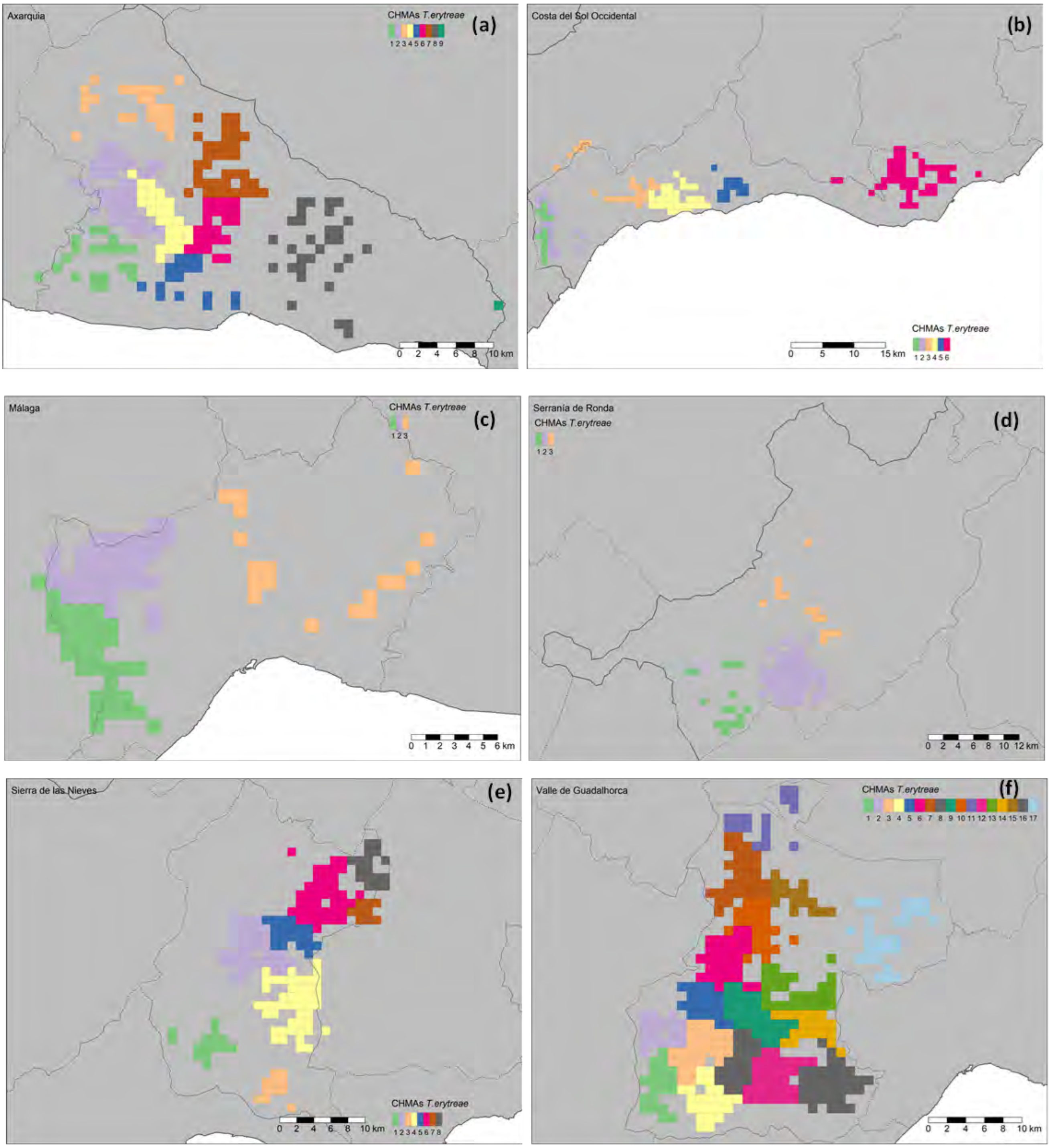

Figure 34. CHMAs for *T. erytreae* within Málaga province at comarca level.

Axarquía	CHMAs	Average risk	Area citrus (km2)	N cells
D. citri	1	0.26	0.06	21
	2	0.26	0.18	21
	3	0.13	0.22	25
	4	0.18	0.98	24
	5	0.28	0.19	17
	6	0.29	1.58	42
	7	0.14	0.66	41
	8	0.23	0.16	25
	9	0.11	0.11	7
T. erytreae	1	0.22	0.06	21
	2	0.21	0.62	42
	3	0.17	0.22	25
	4	0.26	1.78	26
	5	0.23	0.19	17
	6	0.23	0.47	23
	7	0.18	0.53	37
	8	0.21	0.27	31
	9	0.20	0.00	1

Costa del Sol Occidental	CHMAs	Average risk	Area citrus (km2))	N cells
D. citri	1	0.46	3.68	13
	2	0.34	0.93	20
	3	0.24	0.45	23
	4	0.28	1.10	33
	5	0.27	0.32	14
	6	0.27	0.64	52
T. erytreae	1	0.41	3.60	12
	2	0.27	1.01	21
	3	0.21	0.45	23
	4	0.24	1.10	33
	5	0.22	0.32	14
	6	0.21	0.64	52

Málaga	CHMAs	Average risk	Area citrus (km2))	N cells
D. citri	1	0.47	7.20	36
	2	0.34	5.71	33
	3	0.23	0.38	18
T. erytreae	1	0.45	6.50	33
	2	0.34	6.40	36
	3	0.21	0.38	18

Serranía de la Ronda	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.22	0.17	16
	2	0.18	0.82	52
	3	0.14	0.16	14
T. erytreae	1	0.19	0.17	16
	2	0.18	0.82	52
	3	0.16	0.16	14

Sierra de las Nieves	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.18	0.27	15
	2	0.19	3.10	44
	3	0.24	0.60	11
	4	0.22	2.17	42
	5	0.17	0.69	21
	6	0.20	1.33	36
	7	0.21	0.82	21
	8	0.35	2.41	9
T. erytreae	1	0.19	0.27	15
	2	0.22	3.02	39
	3	0.23	0.60	11
	4	0.21	2.25	47
	5	0.19	0.67	20
	6	0.19	1.42	41
	7	0.36	2.41	9
	8	0.19	0.75	17

Valle de Guadalhorca	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.25	1.09	18
	2	0.28	2.75	22
	3	0.34	3.21	25
	4	0.37	4.98	26
	5	0.30	1.70	18
	6	0.46	9.10	28
	7	0.33	6.31	38
	8	0.43	5.78	23
	9	0.61	10.33	25
	10	0.21	1.90	28
	11	0.32	3.80	39
	12	0.40	4.87	31
	13	0.22	0.12	15
	14	0.22	0.48	16
	15	0.73	3.71	7
	16	0.39	3.99	25
	17	0.19	0.21	30
T. erytreae	1	0.24	1.35	20
	2	0.27	2.02	18
	3	0.36	5.89	29
	4	0.30	2.42	24
	5	0.29	1.88	19
	6	0.45	8.72	29
	7	0.30	4.98	30
	8	0.44	5.82	21
	9	0.63	11.70	28
	10	0.29	2.20	23
	11	0.16	0.52	17
	12	0.28	2.66	30
	13	0.27	2.21	27
	14	0.58	6.13	19
	15	0.20	0.48	16
	16	0.34	5.13	34
	17	0.18	0.21	30

Risk maps for Sevilla province

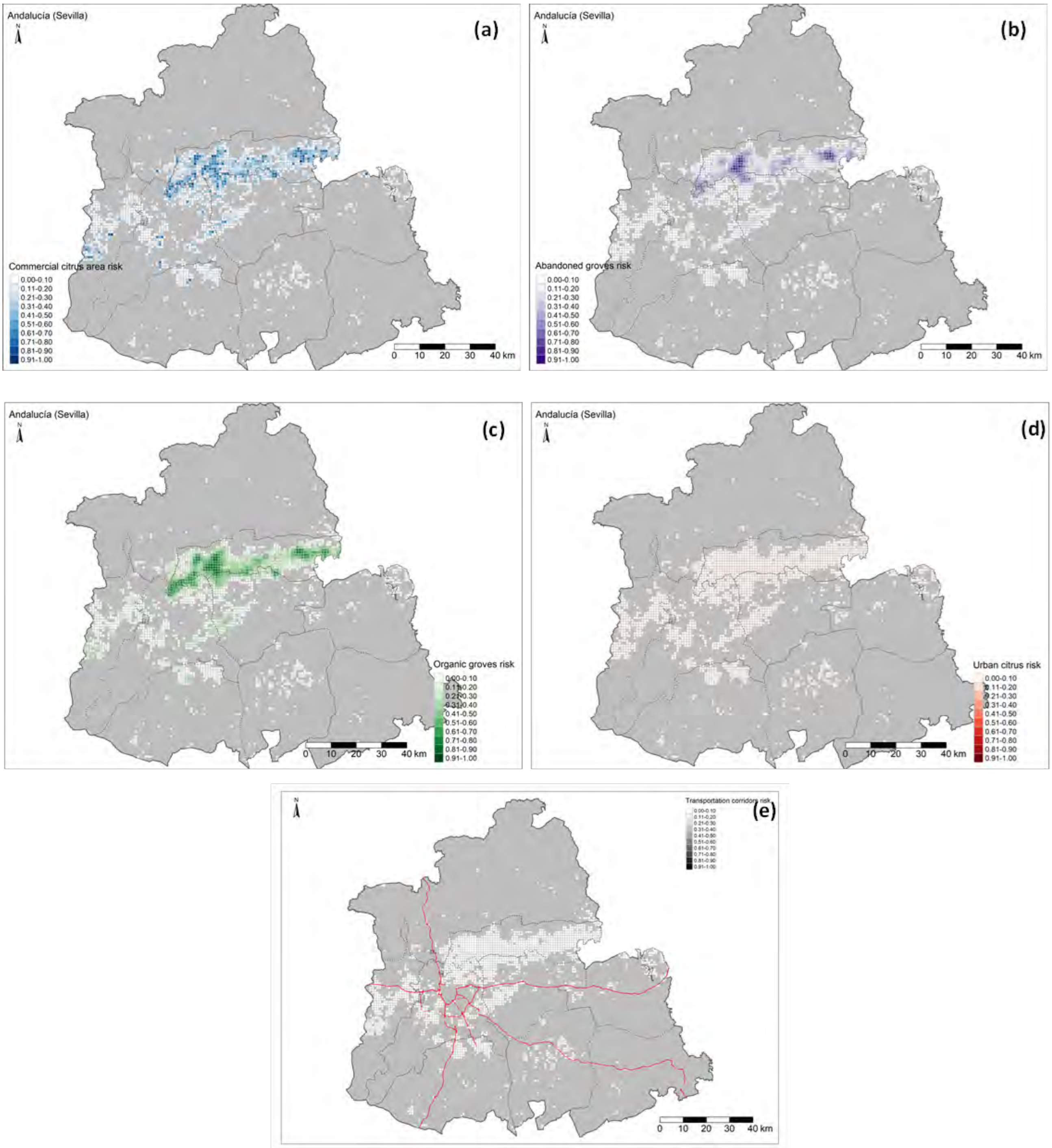

Figure 35. Risk maps for Sevilla province within Andalucía autonomus community.

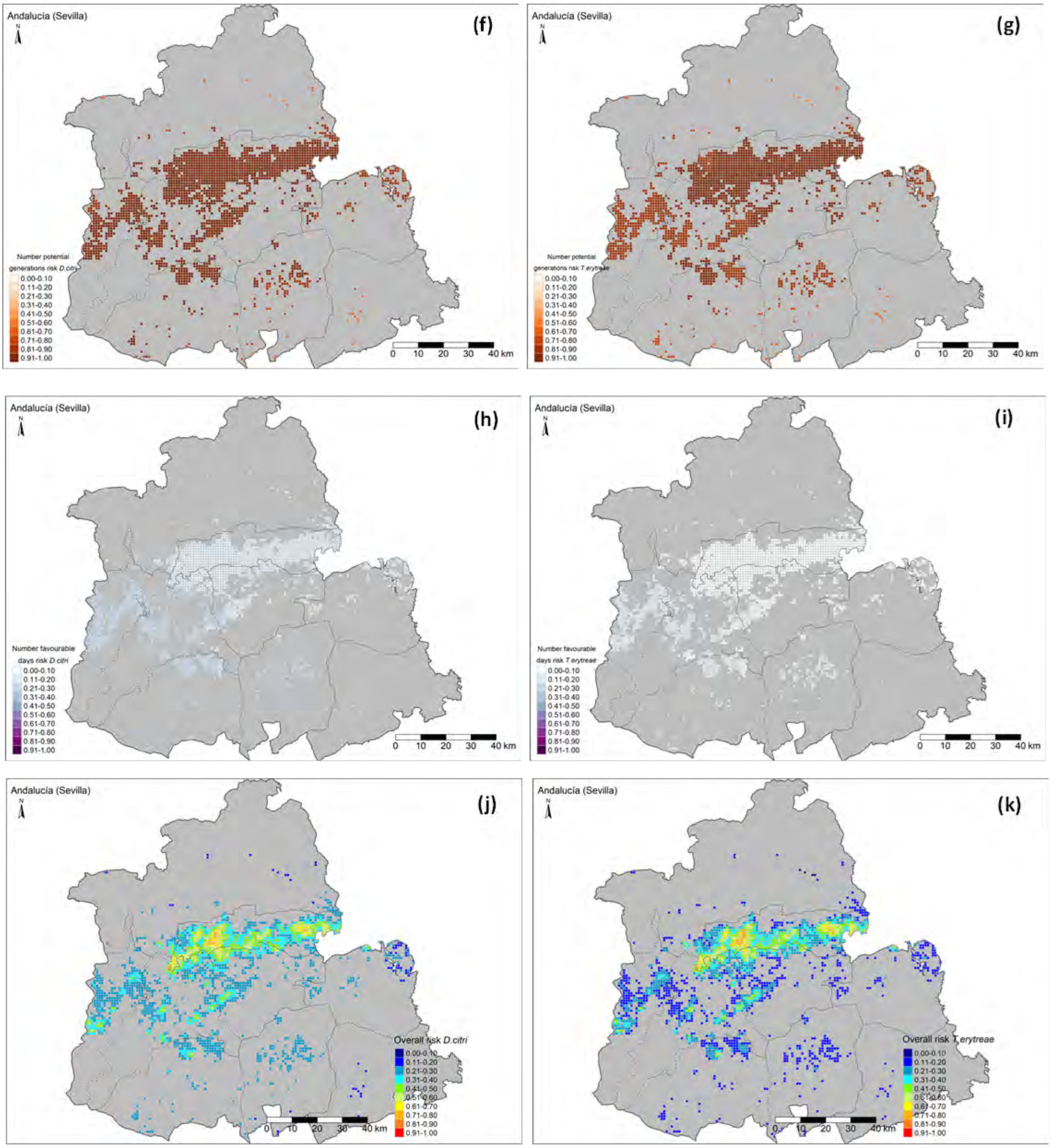

Figure 35. Risk maps for Sevilla province within Andalucía autonomus community.

CHMAs for Sevilla province: graphical and numerical description

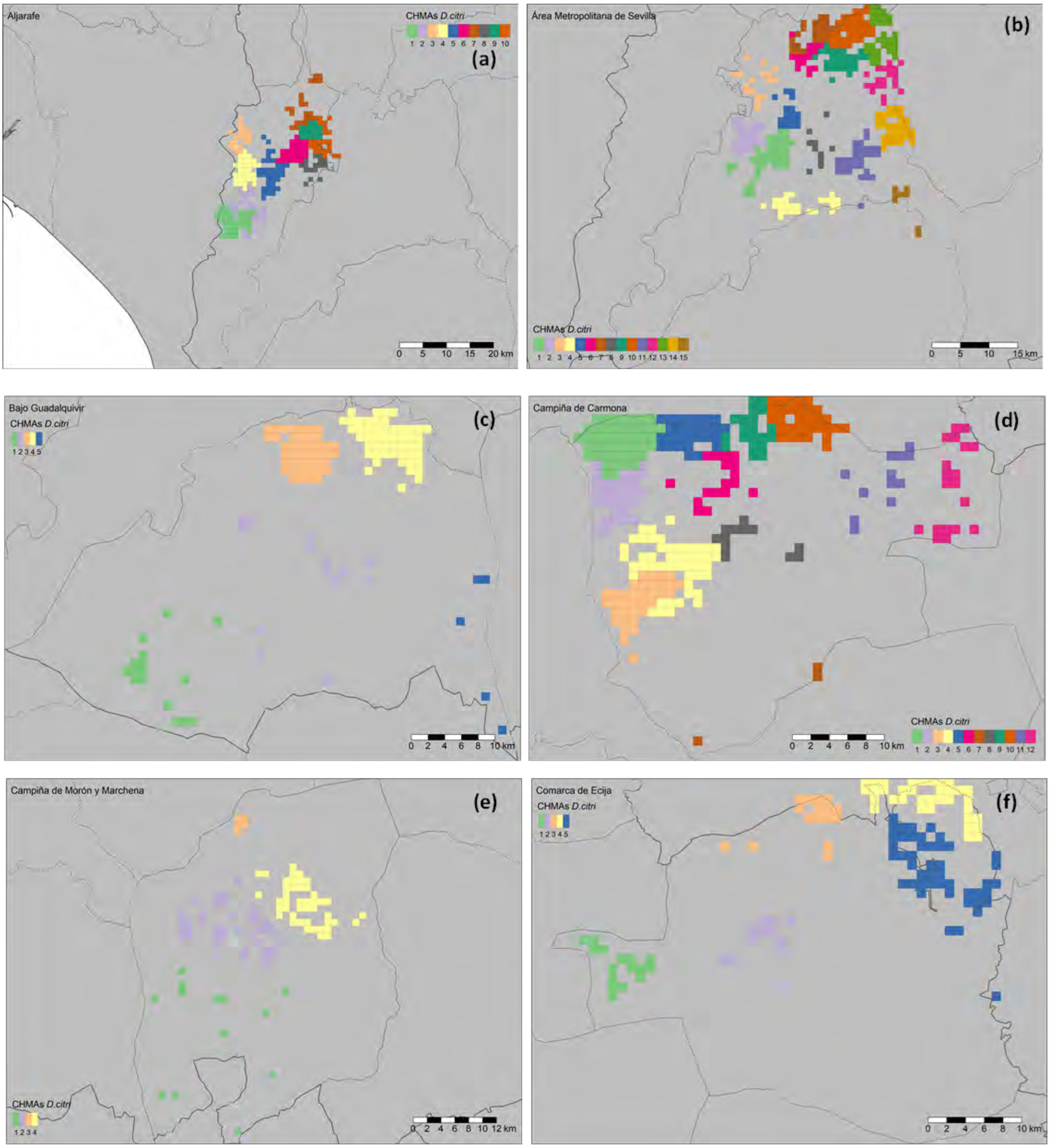

Figure 36. CHMAs for *D. citri* within Sevilla province at comarca level.

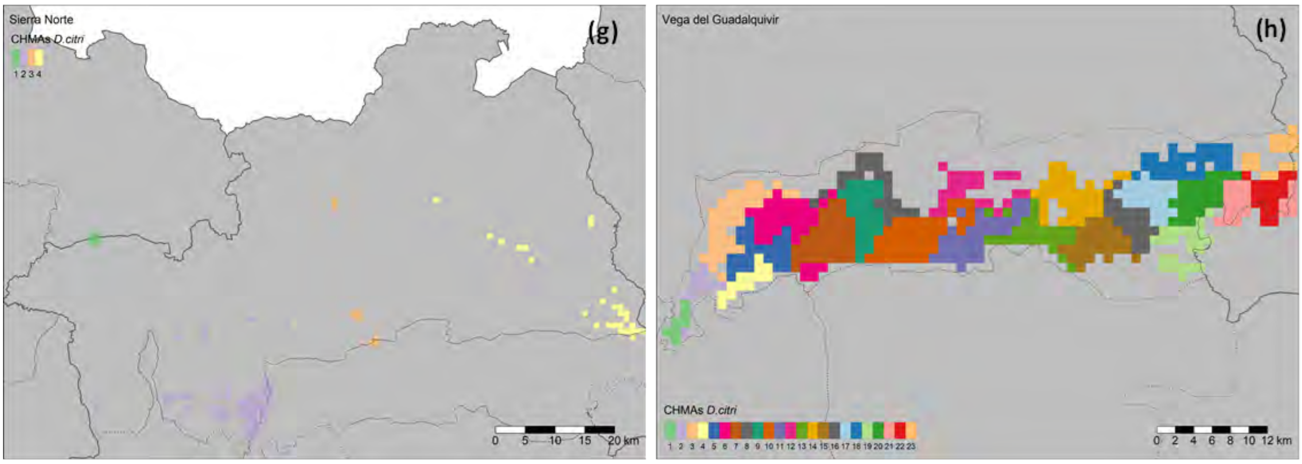

Figure 36. CHMAs for *D. citri* within Sevilla province at comarca level.

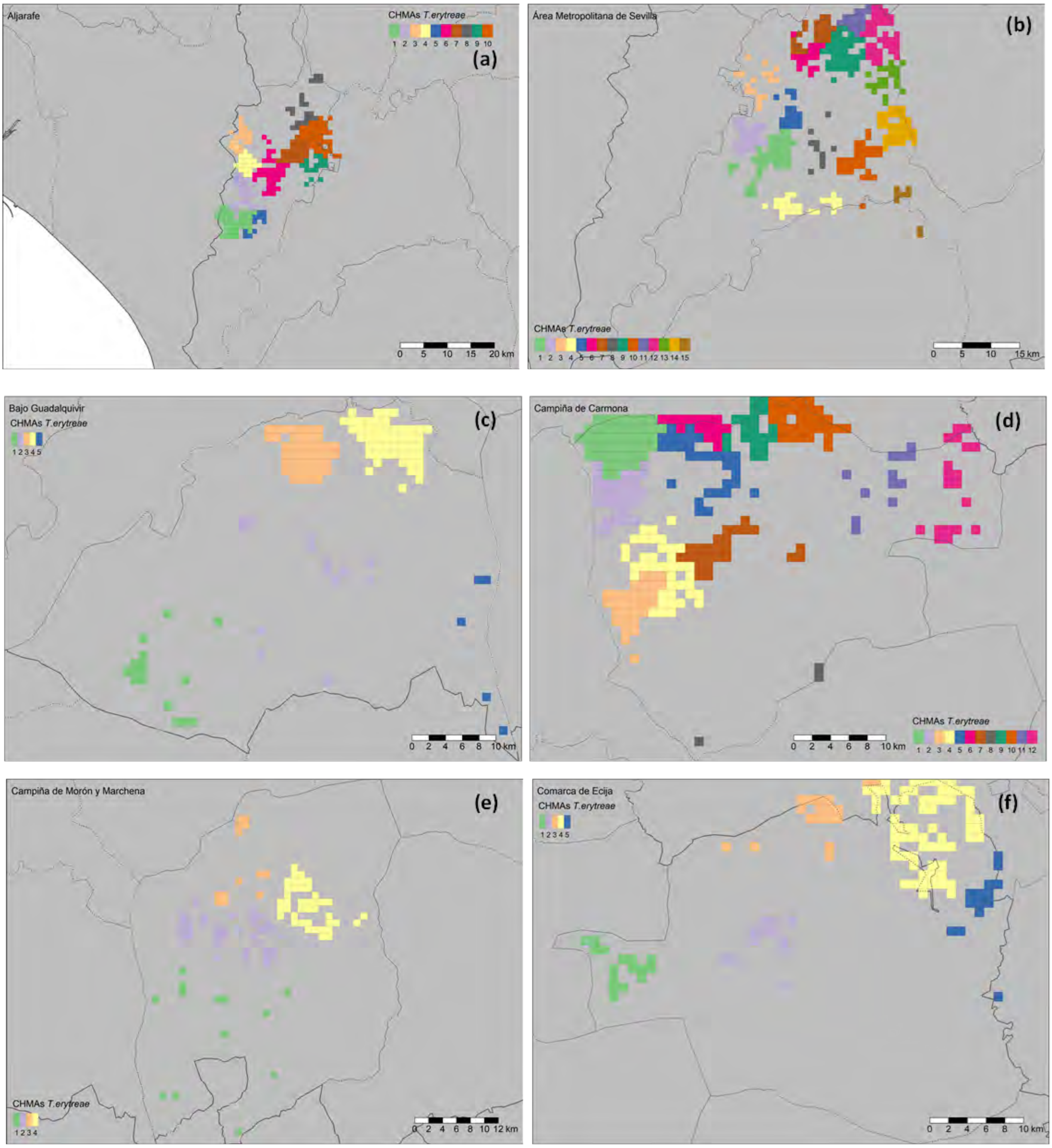

Figure 37. CHMAs for *T. erytreae* within Sevilla province at comarca level.

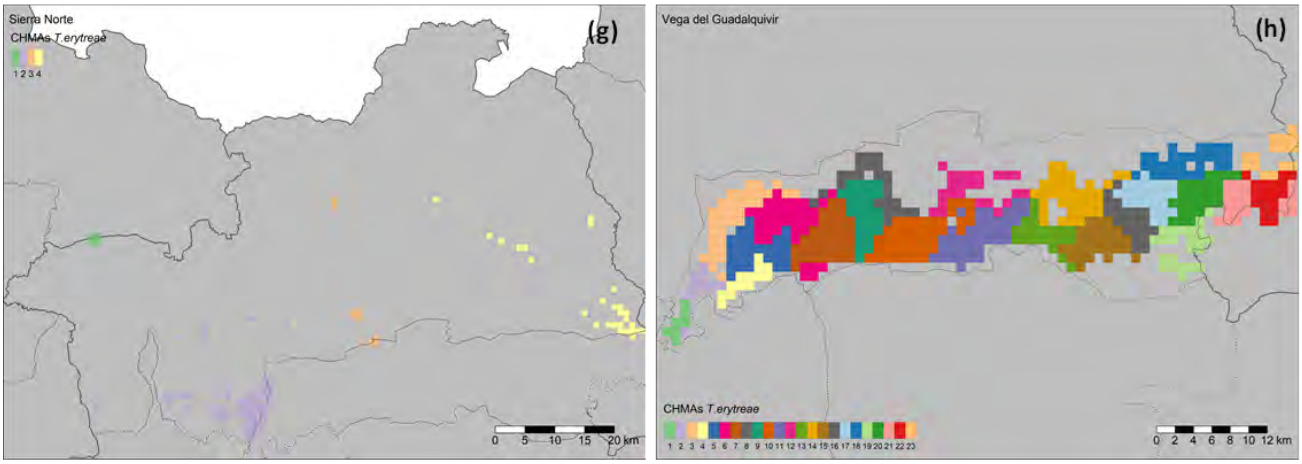

Figure 37. CHMAs for *T. erytreae* within Sevilla province at comarca level.

Aljarate	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.38	11.00	38
	2	0.28	1.41	29
	3	0.25	1.14	21
	4	0.26	1.47	32
	5	0.28	3.45	36
	6	0.29	2.79	27
	7	0.26	1.37	22
	8	0.24	0.34	16
	9	0.35	2.81	17
	10	0.26	0.46	23
T. erytreae	1	0.32	11.00	38
	2	0.20	1.65	31
	3	0.19	1.14	21
	4	0.18	0.48	19
	5	0.20	0.68	11
	6	0.22	3.52	36
	7	0.23	2.79	27
	8	0.20	1.37	22
	9	0.18	0.34	16
	10	0.24	3.27	40

Área Metropolitana Sevilla	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.32	7.14	44
	2	0.24	0.45	26
	3	0.24	0.18	17
	4	0.30	3.27	26
	5	0.27	1.00	17
	6	0.38	3.20	16
	7	0.58	10.76	24
	8	0.25	0.44	10
	9	0.29	2.20	29
	10	0.40	9.64	38
	11	0.31	3.65	32
	12	0.28	2.37	21
	13	0.31	4.66	34
	14	0.31	3.72	35
	15	0.27	1.14	8
T. erytreae	1	0.26	7.14	44
	2	0.18	0.45	26
	3	0.18	0.18	17
	4	0.24	3.27	26
	5	0.20	1.00	17
	6	0.34	3.24	17
	7	0.57	10.76	24
	8	0.19	0.44	10
	9	0.25	3.90	42
	10	0.26	3.65	32
	11	0.46	6.82	17
	12	0.26	5.75	41
	13	0.23	2.37	21
	14	0.26	3.72	35
	15	0.21	1.14	8

Bajo Guadalquivir	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.25	0.10	16
	2	0.24	0.30	14
	3	0.31	3.53	43
	4	0.26	1.98	51
	5	0.22	0.02	5
T. erytreae	1	0.17	0.10	16
	2	0.17	0.30	14
	3	0.24	3.53	43
	4	0.20	1.98	51
	5	0.15	0.02	5

Campiña de Carmona	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.49	19.33	46
	2	0.29	4.60	30
	3	0.35	6.52	35
	4	0.25	1.50	47
	5	0.38	7.79	28
	6	0.24	0.28	17
	7	0.23	0.01	3
	8	0.24	0.37	12
	9	0.35	4.81	20
	10	0.37	8.54	31
	11	0.23	0.18	12
	12	0.23	0.94	19
T. erytreae	1	0.48	19.33	46
	2	0.24	4.60	30
	3	0.32	5.81	30
	4	0.20	1.69	39
	5	0.21	1.64	30
	6	0.45	6.43	15
	7	0.19	0.89	25
	8	0.18	0.01	3
	9	0.32	4.81	20
	10	0.35	8.54	31
	11	0.18	0.18	12
	12	0.19	0.94	19

Campiña de Morón y Marchena	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.20	0.05	13
	2	0.24	1.17	41
	3	0.25	0.18	5
	4	0.23	0.54	44
T. erytreae	1	0.15	0.05	13
	2	0.18	0.96	36
	3	0.19	0.43	13
	4	0.17	0.51	41

Comarca de Écija	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.22	0.27	16
	2	0.21	0.33	12
	3	0.30	2.90	16
	4	0.22	2.34	35
	5	0.20	1.21	46
T. erytreae	1	0.17	0.27	16
	2	0.17	0.33	12
	3	0.28	3.61	18
	4	0.18	2.69	65
	5	0.16	0.14	14

Sierra Norte	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.19	0.27	4
	2	0.31	8.37	56
	3	0.24	0.96	8
	4	0.19	0.20	27
T. erytreae	1	0.15	0.27	4
	2	0.26	8.37	56
	3	0.20	0.96	8
	4	0.14	0.20	27

Vega del Guadalquivir	CHMAs	Average risk	Area citrus (km^2)	N cells
D. citri	1	0.64	4.04	7
	2	0.40	1.54	10
	3	0.29	4.32	37
	4	0.57	7.17	13
	5	0.40	5.55	25
	6	0.50	14.85	36
	7	0.66	19.93	35
	8	0.31	3.08	24
	9	0.48	9.93	27
	10	0.38	9.27	42
	11	0.50	14.90	34
	12	0.26	1.56	24
	13	0.40	7.17	26
	14	0.30	4.75	36
	15	0.30	3.37	28
	16	0.40	5.87	21
	17	0.61	14.56	24
	18	0.30	3.75	29
	19	0.29	3.16	23
	20	0.47	9.74	26
	21	0.57	11.46	21
	22	0.37	3.83	18
	23	0.24	1.00	17
T. erytreae	1	0.65	4.04	7
	2	0.36	1.54	10
	3	0.24	4.05	34
	4	0.56	7.17	13
	5	0.36	5.82	28
	6	0.49	14.85	36
	7	0.68	19.93	35
	8	0.28	3.08	24
	9	0.47	9.93	27
	10	0.36	9.27	42
	11	0.49	16.17	39
	12	0.22	1.56	24
	13	0.37	5.90	21
	14	0.27	4.75	36
	15	0.26	3.37	28
	16	0.39	5.87	21
	17	0.63	14.56	24
	18	0.27	3.75	29
	19	0.26	3.16	23
	20	0.46	9.74	26
	21	0.58	11.46	21
	22	0.36	3.83	18
	23	0.20	1.00	17

5 DATA AND CODE AVAILABILITY

Following open-science principles, data and code will be deposited in a public repository to enhance reproducibility and replicability. To make data and code available in the deliverable submission process, they have been uploaded in .zip file.

All climatic data used in this study can be downloaded from the ERA5-Land dataset(Copernicus Climate Data Store) via the Climate Data Store (CDS) web interface. Data curation and formal analysis have been implemented in the *R* statistical programming (Team, 2014).

6 REFERENCES

References

Joseph M Bové. Huanglongbing: a destructive, newly-emerging, century-old disease of citrus. *Journal of plant pathology*, pages 7–37, 2006.

Sara Garcia-Figuera, Elizabeth E Grafton-Cardwell, Bruce A Babcock, Mark N Lubell, and Neil McRoberts. Institutional approaches for plant health provision as a collective action problem. *Food Security*, 13(2):273–290, 2021.

Chandrika Ramadugu, Manjunath L Keremane, Susan E Halbert, Yong Ping Duan, Mikeal L Roose, Ed Stover, and Richard F Lee. Long-term field evaluation reveals huanglongbing resistance in citrus relatives. *Plant Disease*, 100(9):1858–1869, 2016.

Renato B Bassanezi, Luiz H Montesino, Nelson Gimenes-Fernandes, Pedro T Yamamoto, Tim R Gottwald, Lilian Amorim, and Armando Bergamin Filho. Efficacy of area-wide inoculum reduction and vector control on temporal progress of huanglongbing in young sweet orange plantings. *Plant Disease*, 97(6):789–796, 2013.

Godfrey P Miles, Ed Stover, Chandrika Ramadugu, Manjunath L Keremane, and Richard F Lee. Apparent tolerance to huanglongbing in citrus and citrus-related germplasm. *HortScience*, 52(1):31–39, 2017.

Cesar Monzó and Philip A Stansly. Economic value of conservation biological control for management of the asian citrus psyllid, vector of citrus huanglongbing disease. *Pest management science*, 76(5):1691–1698, 2020.

John V da Graça, Greg W Douhan, Susan E Halbert, Manjunath L Keremane, Richard F Lee, Georgios Vidalakis, and Hongwei Zhao. Huanglongbing: An overview of a complex pathosystem ravaging the world's citrus. *Journal of Integrative Plant Biology*, 58(4): 373–387, 2016.

Cesar Monzo and Philip A Stansly. Economic injury levels for asian citrus psyllid control in process oranges from mature trees with high incidence of huanglongbing. *PLoS One*, 12(4):e0175333, 2017.

James A Tansey, Pilar Vanaclocha, Cesar Monzo, Moneen Jones, and Philip A Stansly. Costs and benefits of insecticide and foliar nutrient applications to huanglongbing-infected citrus trees. *Pest management science*, 73(5):904–916, 2017.

J Belasque Jr, RB Bassanezi, PT Yamamoto, AJ Ayres, A Tachibana, AR Violante, A Tank Jr, F Di Giorgi, FEA Tersi, GM Menezes, et al. Lessons from huanglongbing management in são paulo state, brazil. *Journal of Plant Pathology*, pages 285–302, 2010.

Dhana Raj Boina and Jeffrey R Bloomquist. Chemical control of the asian citrus psyllid and of huanglongbing disease in citrus. *Pest Management Science*, 71(6):808–823, 2015.

Sergio Alvarez, Eric Rohrig, Daniel Solís, and Michael H Thomas. Citrus greening disease (huanglongbing) in florida: Economic impact, management and the potential for biological control. *Agricultural Research*, 5(2):109–118, 2016.

Marc JB Vreysen, Alan S Robinson, Jorge Hendrichs, et al. *Area-wide control of insect pests: from research to field implementation*. Number PA 632.9 A74. Springer, 2007.

T Gottwald, W Luo, and N McRoberts. Risk-based residential hlb/acp survey for california, texas and arizona. *Journal of Citrus Pathology*, 1(1), 2014a.

T Gottwald, W Luo, T Riley, and S Parnell. Commercial risk-based survey for hlb and implications for efficacy of citrus health management areas (chmas). *Journal of Citrus Pathology*, 1(1), 2014b.

R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2021. URL https://www.R-project.org/.

Copernicus Climate Data Store. ERA5-Land hourly data from 1950 to present. https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land?tab=overview#!%2Fdataset%2Freanalysis-era5-land%3Ftab=form. (Accessed on 01.09.2021).

J. Muñoz Sabater, E. Dutra, A. Agustí-Panareda, C. Albergel, G. Arduini, G. Balsamo, S. Boussetta, M. Choulga, S. Harrigan, H. Hersbach, B. Martens, D. G. Miralles, M. Piles, N. J. Rodríguez-Fernández, E. Zsoter, C. Buontempo, and J.-N. Thépaut. ERA5-Land: a state-of-the-art global reanalysis dataset for land applications. *Earth System Science Data*, 13(9):4349–4383, 2021. doi: 10.5194/essd-13-4349-2021. URL https://essd.copernicus.org/articles/13/4349/2021/.

Front matter. In JM Wallace and PV Hobbs, editors, *Atmospheric Science (Second Edition)*, pages ii–iii. Academic Press, San Diego, second edition edition, 2006. ISBN 978-0-12-732951-2. doi: https://doi.org/10.1016/B978-0-12-732951-2.50001-6. URL https://www.sciencedirect.com/science/article/pii/B9780127329512500016.

D Bolton. The computation of equivalent potential temperature. *Monthly Weather Review*, 108(7):1046 – 1053, 1980. doi: 10.1175/1520-0493(1980)108<1046:TCOEPT>2.0.CO;2. URL https://journals.ametsoc.org/view/journals/mwre/108/7/1520-0493_1980_108_1046_tcoept_2_0_co_2.xml.

N Babak. *rts: Raster Time Series Analysis*, 2019. URL https://CRAN.R-project.org/package=rts. R package version 1.0-49.

F.S Davies and L.G Albrigo. *Citricos*. Editorial Acribia, 1999.

A.E De Villiers and P. H. Joubert. *The cultivation of citrus*. ARC-Institute for Tropical and Subtropical Crops, 2006.

Pesca y Alimentación MAPA, Ministerio de Agricultura. Sistema de Información Geográfica de Parcelas Agrícolas (SIGPAC), 2020a. URL https://sigpac.mapa.gob.es/fega/visor/.

Ministerio de Agricutura Pesca y Alimentación Gobierno de España MAPA. Esyrce. Encuesta sobre Superficies y Rendimientos. *MAPA, Ministerio de Agricutura, Pesca y Alimentación Gobierno de España*, page 104–105, 2019. N.I.P.O.: 003-19-051-9.

Ministerio de Agricutura Pesca y Alimentación Gobierno de España MAPA. Producción ecológica. Estadísticas 2019. *MAPA, Ministerio de Agricutura, Pesca y Alimentación Gobierno de España*, pages 14,43:44, 2020b. N.I.P.O.: 003-19-185-4.

EUROSTAT. Grid Data for download per country, 2019. http://www.efgs.info/wpcontent/uploads/Data/GRID/Grid_ETRS89_LAEA_ES_1K.zip.

H. Peifer. About the EEA reference grid, 2011. https://www.eionet.europa.eu/workspace/docs/about-the-eea-reference-grid.pdf.

GEOSTAT. GEOSTAT $1km^2$ population grid, 2011. https://ec.europa.eu/eurostat/cache/GISCO/geodatafiles/GEOSTAT-grid-POP-1K-2011-V2-0-1.zip.

F. Cabanillas. La nueva (y energética) vida de las naranjas. *LA VANGUARDIA*, February 2020. URL https://www.lavanguardia.com/vida/20200219/473659497199/la-nueva-y-energetica-vida-de-las-naranjas.html.

INE). Sevilla: Población por municipios y sexo. https://www.ine.es/jaxiT3/Datos.htm?t=2895, 2020.

CNIG. Redes de transporte, 2021. http://centrodedescargas.cnig.es/CentroDescargas/index.jsp.

Gabriel Díaz-Padilla, J Isabel López-Arroyo, Ignacio Sánchez-Cohen, Rafael Alberto Guajardo-Panes, Gustavo Mora-Aguilera, and Juan Ángel Quijano-Carranza. Áreas de abundancia potencial en méxico del vector del huanglongbing, diaphorina citri (hemiptera: Liviidae). *Revista mexicana de ciencias agrícolas*, 5(7):1137–1153, 2014.

Xavier Martini, Kirsten S. Pelz-Stelinski, and Lukasz L. Stelinski. Factors Affecting the Overwintering Abundance of the Asian Citrus Psyllid (Hemiptera: Liviidae) in Florida Citrus (Sapindales: Rutaceae) Orchards. *Florida Entomologist*, 99(2):178 – 186, 2016. doi: 10.1653/024.099.0204. URL https://doi.org/10.1653/024.099.0204.

Y.H. Liu and J.H. Tsai. Effects of temperature on biology and life table parameters of the asian citrus psyllid, *Diaphorina citri* kuwayama (hemiptera: Psyllidae. *Annals of Applied Biology*, (137):201–206, 2000.

Marie Chavent, Vanessa Kuentz-Simonet, Amaury Labenne, and Jérôme Saracco. Clustgeo: an r package for hierarchical clustering with spatial constraints. *Computational Statistics*, 33(4):1799–1822, 2018.

R Core Team. R foundation for statistical computing; 2018. r: A language and environment for statistical computing. *Vienna, Austria http://www. R-project. org*, 2014.

7 SUPPLEMENTARY MATERIAL

Contents

1 Climatic conditions with an impact on the abundance of the vector

1.1 African citrus Psyllid: T.erytreae:

The sensitivity of *T.erytreae* (mainly eggs and first-instar nymphs) to hot-dry weather has been demonstrated through several studies. The first to report was Van der Merwe [1], who hypothesized about the direct implication of weather on psyllid survival by observing an increase in mortality among the young nymphs when hot summer days arrive. Following this, Catling and Annecke [2] showed, in field tests, that the simultaneous occurrence of **high temperatures and low humidities produce lethal conditions to the developmental stages of *T.erytreae***, while more advances nymphal stages were more tolerant to these conditions [3]. Afterwards, Catling [4, 5, 6] and Green & Catling [7] confirmed that all the stages of the vector were sensitive to hot and dry days with high vapour pressure deficits (VPS), in fact, these conditions were **lethal to eggs and first instar nymphs**. In particular, **the sum of three consecutive days with VPS >25.9 mmHg (34.6 mbar) caused the 70% mortality of eggs and first instar nymphs** [4, 5, 6, 7, 8]. Additionally, these extreme weather conditions could cause an indirect mortality at the nymphal stages by affecting the conditions and quality of the host plant [7]. Moreover, **temperatures above 30ºC with relative humidity below 25%, were lethal to specific life stages, such as eggs and first instar nymphs, as they are vulnerable to desiccation under these conditions** [8]. Furthermore, the wind can increase the lethal effect of hot, dry conditions by increasing the evaporative power of the air [4, 9, 10].

Lastly, Catling [5], and Green and Catling [7], noted that nymphs develop with significant difficulty in mature leaves, and for successful development, they need the availability of soft plant tissues.

All this seems to be the reasons why its dispersal capacity has been limited to areas with temperatures lower than 32ºC combined with 30% relative humidity, areas where citrus growth flushes tend to be prolonged [11, 7, 4, 5, 12]. Nevertheless, some studies have demonstrated that among the difficulty, populations can develop in hot and dry climates or climates with high temperature and frequent rain, as occurs (among others) in Letaba district, Transvaal (both Limpopo province) and Swaziland [13, 7, 4].

1.2 Asian citrus Psyllid: D.citri:

A direct correlation between temperature and *D.citri* development has been demonstrated. Liu and Tsai [14] were the first to prove that ***D.citri* failed to complete its development at either 10ºC or 33ºC, determining that the optimal temperatures for development range between 25-28ºC**. Also, they observed that the mean developmental period decreased with the increased temperature as well as the number of eggs produced per female (and its survival), which significantly increased with the increasing temperatures (with a peak of 748.3 eggs/female at 28ºC). Nevertheless, they found that **high temperatures (>29ºC) caused a significant decline in nymphal survivorship**. These results were in line with Sekelled and Hoy [15] who observed that *D.citri* decreased laying eggs when the individuals were fed at 34ºC. It was also in line with Nakata [16], who found that about 80% of nymphs died at temperatures higher than 32ºC and lower than 15ºC, and that nymphs grew faster at higher temperatures but, **development decreased with temperatures over 32.5ºC**. Paiva [17], similarly to Liu and Tsai [14], observed that the **highest fecundities were between 25ºC - 28ºC**.

Narouei-khandan et al. [18] established that *D.citri* was inhibited when the **mean temperature in the warmer season was higher than 33°C**.

Hall, Wenninger & Hentz's [19] noticed that **females' number of eggs released increased when the temperature ranged between 17 and 32 degrees**. Estimating a peak of lay at 29.6°C, a temperature slightly higher than that observed by Liu and Tsai [14]. Moreover, they observed that a hard or severe freeze event might kill and eliminate *D.citri* for some periods by killing flushes, leaves and most of the immature stages, agreeing with Liu and Tsai [14] that low temperatures are lethal for this psyllid. However, [19] also observed that a cold acclimation of the colony could occur, and a moderate number of individuals could survive a significant freeze event. They determined that the lethal time of exposure for 95% mortality of eggs, nymphs and adults was significantly lower than the one estimated by Liu and Tsai [14]. Being for approximately eight hours of exposure, -4.5°C for eggs hatching and adults survival and -5.5°C for nymphal survival. In addition, they observed and established more significant thresholds for the oviposition, which were between 16 and 41.6°C. Aubert [20, 21] found similar results to [19] by observing that *D.citri* acclimatized to the high temperatures of Saudi Arabia, surviving up to 45°C.

All these studies [19, 14, 20, 21] proved a direct relationship between the presence of new shoots and the survival of eggs and the first developmental stages of nymphs.

2 Maximum number of individual per tree

2.1 African citrus Psyllid: T.erytreae:

Under optimum conditions, Catling [22] and Van den Berg et al.[23], found that the fecundity of *T.erytreae* was 31 - 2542 (mean 827) and 102 - 2335 (mean 982), respectively. These results were in line with Moran and Buchan [24], which found that the fecundity of *T.erytreae* in harder leaves and soft leaves was 631 and 1205 eggs, respectively. But, it was in contrast to Van der Merwe [1], who found that the fecundity of *T.erytreae* was much lower, with 197 - 502 (mean 288) and 109-560 (mean 327), in harder leaves and soft leaves. The only author who has given more precise data for catches was Catling [10], who said that during the winters of 1968 and 1969 observed that the population's densities remained stable and oscillated around 0.04 colones per 10 square feet (0.929 m^2), giving an estimate of 2850 individuals of all stages at the study site (but it was not give the km or ha of the study site).
To estimate the number of individuals from their fecundity, we would relate it to the number of shoots/year (in the Iberian Peninsula, it will be 3), the number of shoots/m^2, the proportion of occupied shoots and the number of eggs/shoot. With this last value, and using a mortality rate of ±70%, we will obtain the number of adults/m^2.

2.2 Asian citrus Psyllid: D.citri:

D.citri, under optimum conditions, has a fecundity of 633 eggs/female in orange trees infected with HLB [25]. These results were in line with Palomarez-Pérez et al. [26], who noticed that the fecundity rate of the psyllid in healthy trees was between 541-786 eggs/female.García et al. [27] estimate a total of 100000 insects/ ha in Brazil, basing this on the total number of psyllid in a highly infested plant in Brazil (>200 individuals/plant) obtained by Martini et al.[28] and on the density of citrus plant in Brazil estimated by Behlau et al., [29].
As with *T.erytreae*, to estimate the number of individuals from their fecundity, we would relate it to the number of shoots/year (in the Iberian Peninsula, it will be 3) and the number of shoots/m^2 proportion of occupied shoots and number of eggs/shoot. With this value, and using a mortality rate of ± 70%, we will obtain the number of adults per m^2.

3 Mean dispersal distance per year

3.1 African citrus Psyllid: T.erytreae:

T.erytreae does not appear to possess strong dispersal powers as the adults have are not capable of sustained flight [22]. However, some authors have found that *T.erytreae* can invade large areas in a relatively short time when is looking for new feeding and oviposition sites, increasing the colonization area by about 4% per day when flushes are available [30, 31].Being able to **fly for at least 1.5km when forced by an external stimulus (as the lack of flushes in the origin field)** [31, 32]. Females have a higher propensity than males for long flights, probably due to the need to find plants with new shoots on which to oviposit [32, 31]. The wind is an essential factor in the passive dispersal and spatial infestation of *T.erytreae* [32, 33]. Nevertheless, long-distance dispersal of *T.erytreae* appears to require human activity.

3.2 Asian citrus Psyllid: D.citri:

Temperature, humidity, and favourable/unfavourable conditions (i.e. lack of young flush, insecticidal applications) **have been proved to influence the propensity of *D.citri* to make long or short flights** [34, 35, 36, 37]. Under laboratory conditions (without wind), ***D.citri* can fly continuously up to 2.4km** [38]. In the field, marking and recapture of wild *D.citri* showed that adults can disperse, without wind assistance, more than 2000 m within 12 days [39, 37]. In addition, wind and human-mediated transportation events might facilitate the long rate dispersal of psyllids, with ranges from 90 up to 470 km [40, 41, 35, 37, 42, 43, 20]. Nevertheless, *D.citri* is usually only spread locally by natural dispersal [37, 19].

4 Transportation corridors, nurseries and packing houses effects in vector abundance

Bayles et al.[35], Lewis-Rosenblum et al.[37], and Godofrey et al.[44] found that ***D.citri* hotspots in the managed fields were strongly associated with the urbanized regions**. These authors suggested that it could be because these urban citruses can suppose a suitable habitat when the conditions on the groove are unfavourable (i.e. after insecticide application, absence of new flushes, etc.)

Moreover, it has been demonstrated that there exists a frequent movement of *D.citri* adults between managed and unmanaged (or abandoned) citrus orchards in USA [41, 37, 19, 45, 46]. Furthermore, several introductions of HLB-positive *D.citri* have been detected in baggage and in citrus trailers from other citrus areas where the disease is already established, indicating that *D.citri* can be transported a long distance with harvested citrus fruit [47].

The same was detected by Halbert et al., [48] in commercial plant nurseries, where they found that, despite the controls carried out by the Florida Department of Agriculture and Consumer Services (Division of Plant Industry (DPI)), 9.7% of the 1.186 tested *D.citri* samples collected from plants for sale were positive to HLB.

5 Supplementary References

References

[1] C.P Van der Merwe. The Citrus psylla (*Trioza merwei*, Pettey). *Journal of the Department of Agriculture, Union of South Africa, Oretirua, Gov Print, Station . Off.Repr*, pages 135–141, 1923.

[2] H.D Catling and D.P Annecke. Ecology of citrus psylla in the Letaba district of Northern Transvaal. *South Agrican Journal of Agricultural Science*, 410:8–17, 1968.

[3] V.C Moran and J.R Blowers. On the biology of the South African citrus psylla,*Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae), on Citrus and four indifenous host plants. *Journal of the Entomological Society of Southern Africa*, 31:391–402, 1968.

[4] H.D Catling. The bionomics of the South African citrus psylla, *Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae) I. The influence of the flushing rhythm of citrus and factors which regulate flushing. *Journal of the Entomological Society of Southern Africa*, 32:191–208, 1969a.

[5] H.D Catling. The bionomics of the South African citrus psylla, *Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae) III. The influence of extremes of weather on survival. *Journal of the Entomological Society of Southern Africa*, 32(2):273–290, 1969c.

[6] H.D Catling. The bionomics of the South African citrus psylla, *Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae) VI. Final population studies and a discussion of population dynamics. *Journal of the Entomological Society of Southern Africa*, 35(2): 235–251, 1972.

[7] G.C Green and H.D Catling. Weather-Induced mortality of the citrus psylla,*Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae), a vector of Greening virus, in some citrus producing areas of Southern Africa. *Agr.Meteorol*, 8:305–317, 1971.

[8] G. Cook, V.Z. Maqutu, and S.P. van Vuuren. Population Dynamics and Seasonal Fluctuation in the Percentage Infection of Trioza erytreae with 'Candidatus' Liberibacter Africanus, the African Citrus Greening Pathogen, in an Orchard Severely Infected with African Greening and Transmission by Field-Collected Trioza erytreae. *African Entomology*, 22(1):127 – 135, 2014. doi: 10.4001/003.022.0107. URL https://doi.org/10.4001/003.022.0107.

[9] H.D Catling. The bionomics of the South African citrus psylla, *Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae) V. The influence of host plant quality. *Journal of the Entomological Society of Southern Africa*, 32:191–208, 1969a.

[10] H.D Catling. Factors regulating populations of Psyllid vectors of Greening. *International Organization of Citrus Virologist Conference Proceeding*, 5(5):1957–2010, 1972. doi: http://dx.doi.org/10.5070/C56w3265wb.

[11] D. Djeddour, C. Pratt, K. Constantine, I. Rwomushana, and R. Day. The Asian citrus greening disease (huanglongbing): Evidence note on invasiveness and potential economic impacts for East Africa. *CABI Working Paper*, (24):94pp, 2021. doi: https://dx.doi.org/10.1079/CABICOMM-62-8158.

[12] EFSA, R. Baker, G. Gilioli, C. Behring, D. Candiani, A. Gogin, T. Kaluski, M. Kinkar, O. Mosbach-Schulz, M. Neri Franco, S. Preti, M.C. Rosace, R. Siligato, G. Stancanelli, and S. Tramontini. Candidatus Liberibacter Pest Report and Datasheet to support ranking of EU candidate priority pests. June 2019. doi: 10.5281/zenodo.2788905. URL https://doi.org/10.5281/zenodo.2788905. EU; XLS; alpha@efsa.europa.eu.

[13] J.M. Bové. Huanglongbing: A destructive, newly-emerging, century-old disease of citrus. *Journal of Plant Pathology*, 88(1): 7–37, 2006. ISSN 11254653, 22397264. URL http://www.jstor.org/stable/41998278.

[14] Y.H. Liu and J.H. Tsai. Effects of temperature on biology and life table parameters of the asian citrus psyllid, *Diaphorina citri* kuwayama (hemiptera: Psyllidae. *Annals of Applied Biology*, (137):201–206, 2000.

[15] L.H Skelley and M.A Hoy. A synchronous rearing method for the asian citrus psyllid and its parasitoids in quarantine. *Biological Control*, 29(1):14–23, 2004. ISSN 1049-9644. doi: https://doi.org/10.1016/S1049-9644(03)00129-4. URL https://www.sciencedirect.com/science/article/pii/S1049964403001294.

[16] T. Nakata. Temperature-dependent development of the citrus psyllid, *Diaphorina citri* (homoptera: Psylloidea), and the predicted limit of its spread based on overwintering in the nymphal stage in temperate regions of japan. *Applied Entomology and Zoology*, 41:383–387, 2006.

[17] P.E. Paiva. *Distribuição espacial e temporal, inimigos naturais e tabela de vida ecológica de Diaphorina citri Kuwayama (Hemiptera: Psyllidae) em citros em São Paulo*. dissertation, Universidade de São Paulo. Escola Superior de Agricultura "Luiz de Queiroz", 2009.

[18] H.A. Narouei-Khandan, S.E. Halbert, S.P. Worner, S.P. Worner, and A. H.C. Van Bruggen. Global climate suitability of citrus huanglongbing and its vector, the Asian citrus psyllid, using two correlative species distribution modeling approaches, with emphasis on the USA. *European Journal of Plant Pathology*, 144:655–670, 2016. doi: https://doi.org/10.1007/s10658-015-0804-7.

[19] D.G. Hall, E.J. Wenninger, and M.G. Hentz. Temperature studies with the Asian citrus psyllid, *Diaphorina citri*: cold hardiness and temperature thresholds for oviposition. *Journal of insect science (Online)*, 11(83), 2011. doi: https://doi.org/10.1673/031.011.8301.

[20] B. Aubert and X.Y Hua, editors. *Monitoring flight activity of Diaphorina citri on citrus and murraya canapies.*, volume 4-10 of *Proceeding of the 4th International Asia Pacific Conference on Citrus Rehabilitation*.

[21] B Aubert. *Trioza erytreae*Del Guercio and *Diaphorina citri* Kuwayama (Homoptera: Psylloidea), the two vectors of Citrus Greening Disease: Biological aspects and possible control strategies. *Fruits*, 42(3):149–162, 1987.

[22] H. D. Catling. Notes on the biology of the South African citrus psylla, *Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae). *Journal of the Entomological Society of Southern Africa*, (36):299–306, 1973.

[23] M.A. Van den berg. The Citrus Psylla, *Trioza erytreae* (Del Guercio) (Hemiptera: Triozidae): A Review. *Agriculture, Ecosystems and Environment*, (30):71–1946, 1990.

[24] V.C Moran and P.R Buchan. Oviposition by the citrus psylla *Trioza erytreae* (homoptera:psyllidae), in relation to leaf hardness. *Entomologia experimentalis et applicata*, 18(1), 1975. ISSN 0013-8703.

[25] A.K. Ramírez-Sánchez, L.D. Ortega-Arenas, J.J. Velázquez-Monreal, and J.M Valdez-Carrasco. Supervivencia y Reproducción de *Diaphorina citri* en Plantas de Naranja y Lima Mexicana Sanas e Infectadas con Candidatus Liberibacter asiaticus. *Southwestern Entomologist*, 41(3):801 – 812, 2016. doi: 10.3958/059.041.0322. URL https://doi.org/10.3958/059.041.0322.

[26] M. Palomares-Pérez, E.G. Córdoba-Urtiz, J.A. Sánchez-González, N.I. Medina-García, R.H. Hernández-Mendoza, V.H. Pérez-Díaz, and H.C Arredondo-Bernal. Aspectos biológicos de *Diaphorina citri* (hemiptera: Liviidae) bajo condiciones no controladas en invernadero. *Revista Colombiana de Entomología*, 41(2):228–234, 2015.

[27] A.G. Garcia, J.A. Jamielniak, A.J.F. Diniz, and J.R.P. Parra. Title : Flatten the huanglongbing (hlb) curve! the importance of ipm to limit its vector, the asian citrus psyllid. 2021.

[28] X. Martini, K.S. Pelz-Stelinski, and L.L Stelinski. Absence of windbreaks and replanting citrus in solid sets increase density of asian citrus psyllid populations. *Agriculture, Ecosystems Environment*, 212:168–174, 2015. ISSN 0167-8809. doi: https://doi.org/10.1016/j.agee.2015.06.027. URL https://www.sciencedirect.com/science/article/pii/S0167880915300104.

[29] EFSA, F. Behlau, R.B. Bassanezi, S.A. Lopes, I. Barbosa, J.C. Sala, and V.G Trombin. Levantamento de doenças dos citros: HLB, CVC e Cancro Cítrico no citurão citrícola de São Paulo e Triângulo/Sudoeste Mineiro. *Fundecitrus*, pages 1–56, 2017. doi: https://www.fundecitrus.com.br/pdf/levantamentos/levantamento-doencas-2017.pdf.

[30]

[31] M. A. Van den Berg and V.E Deacon. Dispersal of the citrus psylla, *Trioza erytreae* (hemiptera: Triozidae), in the absence of its host plants. 1988.

[32] G.E.M Cocuzza, A. Urbaneja, E. Hernández-Suárez, F. Siverio, S. Di Silvestro, A. Tena, and C. Raspisarda. A review on *Trioza erytreae* (african citrus psyllid), now in mainland europe, and its potential risk as vector of huanglongbing (hlb) in citrus. *Journal of Pest Science*, (90):1–17, 2017. doi: ttps://doi.org/10.1007/s10340-016-0804-1.

[33] J.L. Tamesse and J. Messi. Facteurs influençant la dynamique des populations du psylle africain des agrumes *Trioza erytreae* del guercio (hemiptera: Triozidae) au cameroun. *International Journal of Tropical Insect Science*, 24(3):213–227, 2004. doi: 10.1079/IJT200429.

[34] C. A. Antolinez, T. Moyneur, X. Martini, and M.J. Rivera. High temperatures decrease the flight capacity of *Diaphorina citri* kuwayama (hemiptera: Liviidae). *Insects*, 12(5), 2021. ISSN 2075-4450. doi: 10.3390/insects12050394. URL https://www.mdpi.com/2075-4450/12/5/394.

[35] B.R. Bayles, S.M. Thomas, G.S. Simmons, E.E. Grafton-Cardwell, and M.P. Daugherty. Spatiotemporal dynamics of the southern california asian citrus psyllid (*Diaphorina citri*) invasion. *PLOS ONE*, 12(3):1–17, 03 2017. doi: 10.1371/journal.pone.0173226. URL https://doi.org/10.1371/journal.pone.0173226.

[36] A. F. Tomaseto, R. Krugner, and J. R. S. Lopes. Effect of plant barriers and citrus leaf age on dispersal of *Diaphorina citri* (hemiptera: Liviidae). *Journal of Applied Entomology*, 140(1-2):91–102, 2016. doi: https://doi.org/10.1111/jen.12249. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/jen.12249.

[37] H. Lewis-Rosenblum, X. Martini, S. Tiwari, and L.L Stelinski. Seasonal movement patterns and long-range dispersal of asian citrus psyllid in florida citrus. *Journal of Economic Entomology*, 108(1):3–10, 2015. doi: doi:10.1093/jee/tou008.

[38] X. Martini, A. Hoyte, and L.L Stelinski. Abdominal Color of the Asian Citrus Psyllid (Hemiptera: Liviidae) is Associated with Flight Capabilities. *Annals of the Entomological Society of America*, 107(4):842–847, 07 2014. ISSN 0013-8746. doi: 10.1603/AN14028. URL https://doi.org/10.1603/AN14028.

[39] L.L Stelinski. Ecological aspects of the vector-borne bacterial disease, citrus greening (huanglongbing): Dispersal and host use by asian citrus psyllid, *Diaphorina Citri* kuwayama. *Insects*, 10, 2019.

[40] EFSA Panel on Plant Health (PLH), C. Bragard, K. Dehnen-Schmutz, F. Di Serio, P. Gonthier, M.A. Jacques, J.A. Jaques Miret, A.F. Justesen, C.S. Magnusson, P. Milonas, J.A. Navas-Cortes, S. Parnell, R. Potting, P. L. Reignault, Hh. Thulke, W. Van der Werf, A.C. Vicent, J. Yuen, L. Zappalà, V. Kertesz, F. Streissl, and A. MacLeod. Pest categorisation of *Diaphorina citri*. *EFSA Journal*, 19(1):e06357, 2021. doi: https://doi.org/10.2903/j.efsa.2021.6357. URL https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/j.efsa.2021.6357.

[41] N. McRoberts, S.G. Figuera, S. Olkowski, B. McGuire, W. Luo, D. Posny, and T. Gottwald. Using models to provide rapid programme support for california's efforts to suppress huanglongbing disease of citrus. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 374(1776):20180281, 2019. doi: 10.1098/rstb.2018.0281. URL https://royalsocietypublishing.org/doi/abs/10.1098/rstb.2018.0281.

[42] R.T. Gottwald. Current epidemiological understanding of citrus huanglongbing. *Annual Review of Phytopathology*, 48(1):119–139, 2010. doi: 10.1146/annurev-phyto-073009-114418. URL https://doi.org/10.1146/annurev-phyto-073009-114418. PMID: 20415578.

[43] Y Sakamaki. Possible migration of the asian citrus psyllid, *Diaphorina cittri* kuwayama (homoptera: Psyllidae) between and within islands. *Occasional Papers Kagoshima. University Research Center for the Pacific Islands*, 42:121–125, 2005.

[44] K. E. Godfrey, C. Galindo, J.M Patt, and M. Luque-Williams. Evaluation of Color and Scent Attractants Used to Trap and Detect Asian Ctirus Psyllid (Hemiptera: Liviidae) in Urban Environments. *Florida Entomologist*, 96(4):1406 – 1416, 2013. doi: 10.1653/024.096.0420. URL https://doi.org/10.1653/024.096.0420.

[45] D. R. Boina, W. L. Meyer, E. O. Onagbola, and L. L. Stelinski. Quantifying dispersal of *Diaphorina citri* (Hemiptera: Psyllidae) by immunomarking and potential impact of unmanaged groves on commercial citrus management. *Environmental entomology*, 38(4):1250–1258, 2009. doi: 10.1603/022.038.0436. URL https://doi.org/10.1603/022.038.0436.

[46] S. Halbert, C. Niblett, K. Manjunath, R. Lee, and L. Brown. Establishment of two new vectors of citrus pathogens in florida. *Proceedings of the Sixth International Citrus Congress*, pages 1016–1017, 01 2000.

[47] S.E. Halbert, K.L. Manjunath, C. Ramadugu, M.W. Brodie, S.E. Webb, and R.F Lee. Trailers transporting oranges to processing plants plants move asian citrus psyllids. *The Florida Entomologist*, 93(1):33–38, 2010. ISSN 00154040, 19385102. URL http://www.jstor.org/stable/40587717.

[48] S.E Halbert, K. Manjunath, C. Ramadugu, and R.F Lee. Incidence of Huanglongbing-Associated 'Candidatus Liberibacter Asiaticus' in Diaphorina citri (Hemiptera: Psyllidae) Collected from Plants for Sale in Florida. *Florida Entomologist*, 95(3):617 – 624, 2012. doi: 10.1653/024.095.0312. URL https://doi.org/10.1653/024.095.0312.