MODELLING INVASION RISK MAPS FOR ALIEN PLANTS

Application in Mediterranean sea cliffs with endemic species

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LIFE med CLIFFS

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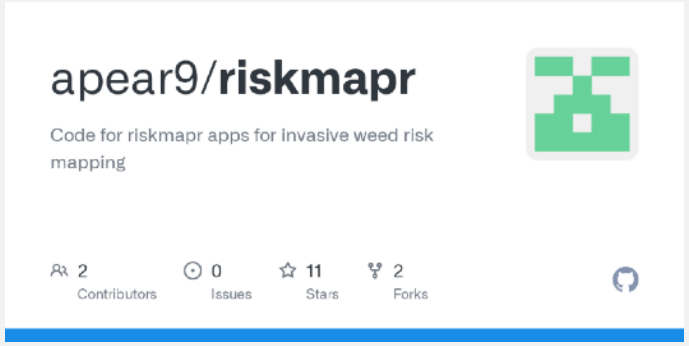
RISKMAPR

- Mapping tool that allows land managers to identify priority areas with limited data to monitor and quickly manage weed invasions



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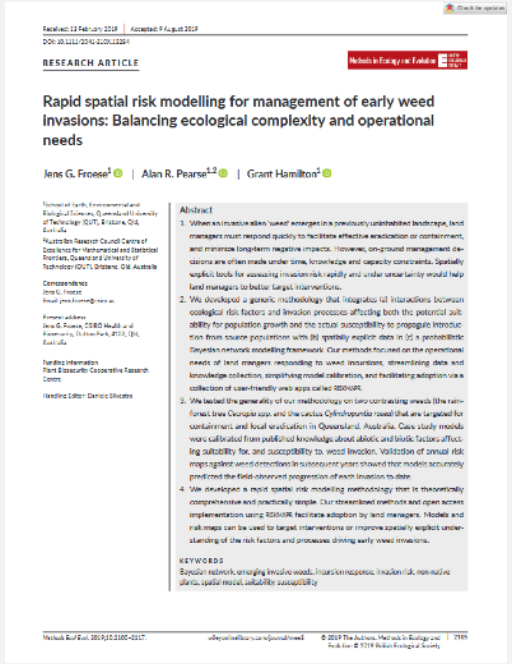


RESEARCH ARTICLE

Rapid spatial risk modelling for management of early weed invasions: Balancing ecological complexity and operational needs

Jens G. Froese[1] | Alan R. Pearse[1,2] | Grant Hamilton[1]

INVASION RISK MODELING

A **Theoretical models of 33 invasive species**

1. Identify risk factors
2. Build a conceptual model
3. Obtain spatial data and calibrate the model

B **Risk maps with “riskmapr”: Land management**

4. Link spatial data
5. Prepare propagule supply and dispersal models
6. Prepare risk maps with "RISKMAPR"

THEORETICAL MODELS

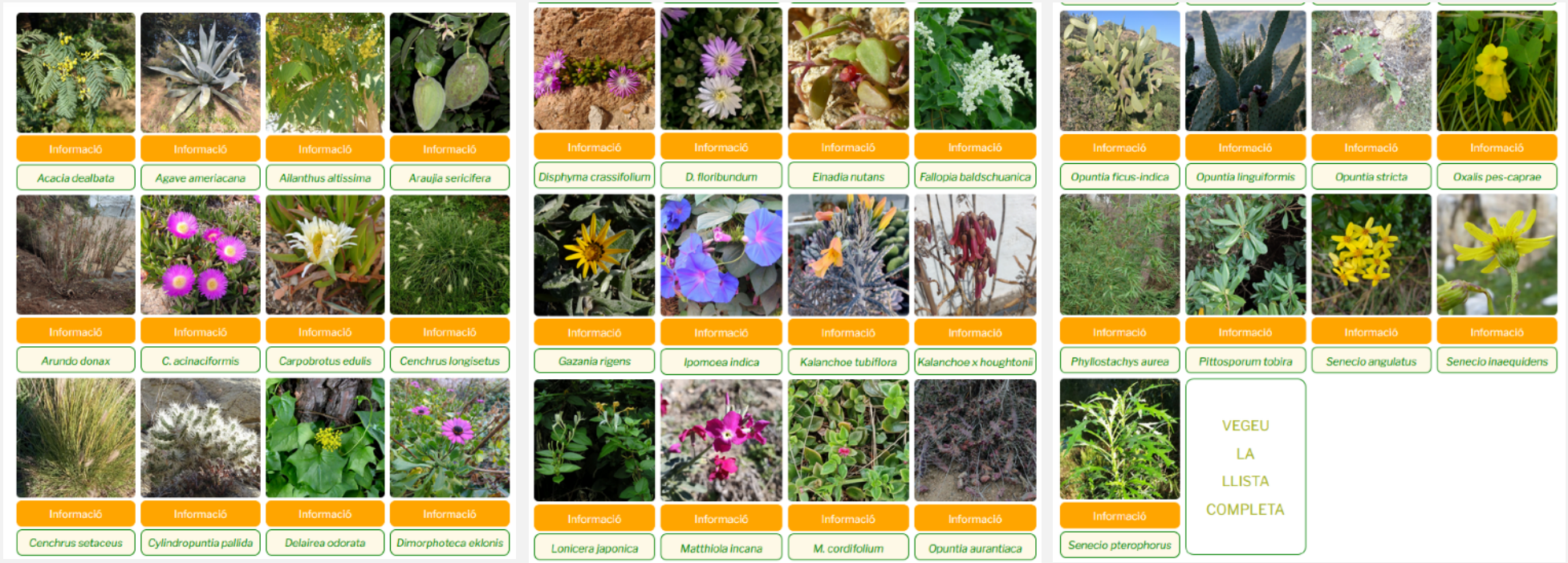
33 INVASIVE SPECIES

RISK FACTORS AND SPATIAL REPRESENTATION

Factor de risc & definició	Mapa utilitzat	Classificació dels atributs espacials	Valor de risc		
Pendent Si els fragments són capaços d'establir-se en diferents vessants	Mapa derivat del Model d'Elevació del Terreny de Catalunya 5x5 metres (MET-5) v1	**Apte**: 0-25 **Òptim**: 25 – 50 **Apte**: 50-75 **Molt poc apte**: >75	50 100 50 25	Establiment	Idoneïtat	Susceptibilitat
Humitat Si el drenatge del sòl dona suport al creixement i la supervivència de les plantes	Inclòs al mapa de sòls de Catalunya a escala 1:250.000 (MSC250M).	**Apte**: Sols ben drenats, ràpidament drenats i molt ràpidament drenats **Poc apte**: Imperfectament drenats **No apte**: Saturats	100 50 0			
Tipus d'usos del sòl Si els usos del sòl admeten el reclutament dens de plàntules	Mapa d'Usos del Sòl de Catalunya (MSCS) v1.0 – 2018 (ICGC)	**Principal habitat**: Conreus en transformació, roquissars i congestes **Ben tolerat**: Matollar, sòl nu forestal **Tolerat**: Boscos clars d'esclerofil·les i laurifolis, boscos clars d'aciculifolis, prats i herbassars, etc. **Habitat inadequat**: Altres conreus llenyosos, boscos clars de caducifolis, platges, vinyes, zones verdes, etc **No habitat**: basses; bosc de ribera; boscos densos de caducifolis, planifolis; casc urbà; cursos d'aigua; etc.	100 75 50 25 0			
Temperatura mínima Si les plantes estan exposades a temperatures adverses durant el mes més fred	Fick, S.E. and R.J. Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37 (12): 4302-4315.	**Òptim**: >3°C **Apte**: ≤3°C i >-5°C **No apte**: ≤ -5°C	100 50 0	Persistència		
Presència de *Dactylopius opuntiae* Si les inoculacions i la presència de Dactylopius opuntiae poden empitjorar el creixement i la supervivència de les plantes	Llocs d'inoculació de Dactylopius opuntiae a Opuntia ficus-indica i identificacions de D. opuntiae per part de voluntaris al lloc iNaturalist	Distància a un punt d'inoculació de *D. opuntiae* o observació d'una planta afectada amb *D. opuntiae* **Poc apte**: 0 - 50 m **Moderada**: 50 - 500 m **Apte**: 500 - 1000 m **Molt apte**: >1000 m	25 50 75 100			
Subministrament de propàguls Quantitat de segments potencialment dispersats de poblacions font	Mapa derivat de les observacions de voluntaris i observadors a la plataforma iNaturalist	Àrea de la població amb individus madurs **Molt alt**: ≥20 m2 **Alt**: 10-20 m2 **Moderat**: 1-10 m2 **Baix**: ≤1 m2; poblacions d'immadurs; poblacions de senescents	100 75 50 25	Dispersió		
Dispersió animal (epi-/endozoocòria) Freqüència i densitat dels segments dispersats de poblacions font per animals terrestres i voladors	Mapa derivat de les observacions de voluntaris i observadors a la plataforma iNaturalist	Distància euclidiana radial calculada des de la font més propera **Òptim**: 0 a 200 m **Moderat**: 200 a 750 m **Poc adecuat**: 750 a 2250 m **Inadecuat**: > 2250 m	100 50 25 0			
Dispersió hortícola i jardineria Quants segments poden arribar de possibles fonts de dispersió antropogèniques com jardins privats o àrees particulars	Mapa derivat del Mapa d'Usos del Sòl de Catalunya (MSCS) v1.0 – 2018 (ICGC)	Distància de possibles fonts de dispersió antropogèniques com jardins privats o àrees particulars. **Òptim**: 0 a 10 m **Moderat**: 10 a 20 m **Poc adequat**: 20 a 50 m **Inadequat**: >50 m	100 50 25 0			

33 CALIBRATED INVASIVE PLANT MODELS

- The aim of the LIFE medCLIFFS project is to prepare and calibrate the models for the 33 invasive plants targeted by the project



33 CALIBRATED INVASIVE PLANT MODELS

- The aim of the LIFE medCLIFFS project is to prepare and calibrate the models for the 33 invasive plants targeted by the project
- Most time-consumig process while applying RISKMAPR
- These models can be extrapolated to other regions of the Mediterranean (possibility of making adjustments if needed)
- We will create guidelines on how to use and modify these models, with recommendations on where to obtain the necessary spatial proxies

Example: Opuntia ficus-indica

			Risk factor & definition	Map used	fication of spatial attributes	Risk value
Susceptibility	**Suitability**	**establishment**	**Slope** If fragments are able to be established on different slopes	Map derived from the Terrain Elevation Model of Catalonia 5x5 meters (MET-5) v1	**Suitable** : 0-25 **Optimum** : 25 – 50 **Suitable** : 50-75 **Very unfit** : >75	50 100 50 25
			Soil humidity If soil drainage supports plant growth and survival	Included in the soil map of Catalonia at a scale of 1:250,000 (MSC250M).	**Suitable** : Well-drained, quickly drained and very quickly drained soils **Unsuitable** : Imperfectly drained **Not suitable** : Saturated	100 50 0
			Types of land uses If land use support dense seedling recruitment	Land Use Map of Catalonia (MSCS) v1.0 – 2018 (ICGC)	**Main habitat** : Crops in transformation, rocky areas and congested areas **Well tolerated** : Scrub, bare forest floor **Tolerated** : Clear forests of sclerophylls and laurifolias, clear forests of aciculifolias, meadows and grasslands, etc. **Inappropriate habitat** : Other woody crops, clear deciduous forests, beaches, vineyards, green areas, etc. **Uninhabited** : ponds; riparian forest; dense forests of deciduous, planifolia; urban helmet; watercourses; etc.	100 75 50 25 0
		persistence	**Minimum temperature** If plants are exposed to adverse temperatures during the coldest month	Fick , SE and RJ Hijmans , 2017. WorldClim 2: new 1km spatial resolution weather surfaces for global land areas _ International Journal of Climatology 37 (12): 4302-4315.	**Optimum** : >3°C **Suitable** : ≤3°C and >-5°C **Not suitable** : ≤ -5°C	100 50 0
			Presence of *Dactylopius opuntia* If inoculations and presence of Dactylopius opuntiae can affect plant growth and survival	Dactylopius inoculation sites opuntiae to Opuntia ficus-indica and identifications of D. opuntiae by volunteers on the iNaturalist site	*D. opuntiae* inoculation point or observation of a plant affected with *D. opuntiae* **Not suitable** : 0 - 50 m **Moderate** : 50 - 500 m **Suitable** : 500 - 1000 m **Very suitable** : >1000 m	25 50 75 100
		dispersion	**Supply of propagules** Number of potentially dispersed segments of source infestation	Map derived from the observations of volunteers and observers on the iNaturalist platform	Area of the population with mature individuals **Very high** : ≥20 m2 **Height** : 10-20 m2 **Moderate** : 1-10 m2 **Low** : ≤1 m2; populations of immatures or senescent	100 75 50 25
			Animal dispersal (epi -/ endozoochory) Frequency and density of dispersed segments of source infestations by terrestrial and flying animals	Map derived from the observations of volunteers and observers on the iNaturalist platform	Radial Euclidean distance calculated from the nearest source **Optimum** : 0 to 200 m **Moderate** : 200 to 750 m **Not suitable** : 750 to 2250 m **Unsuitable** : > 2250 m	100 50 25 0
			Horticultural dispersal and gardening How many segments can to arrive of possible sources of anthropogenic dispersion such as private gardens or private areas	Map derived from the Land Use Map of Catalonia (MSCS) v1.0 – 2018 (ICGC)	Distance from possible sources of anthropogenic dispersion such as private gardens or private areas. **Optimum** : 0 to 10 m **Moderate** : 10 to 20 m **Not suitable** : 20 to 50 m **Inappropriate** : >50 m	100 50 25 0

Highly x 3 = Very important | **Weighting x 2 = Moderately important** | **Weighting x 1 = Somewhat important**

STEP 3. OBTAIN SPATIAL DATA AND CALIBRATE THE MODEL

For each identified risk factor:

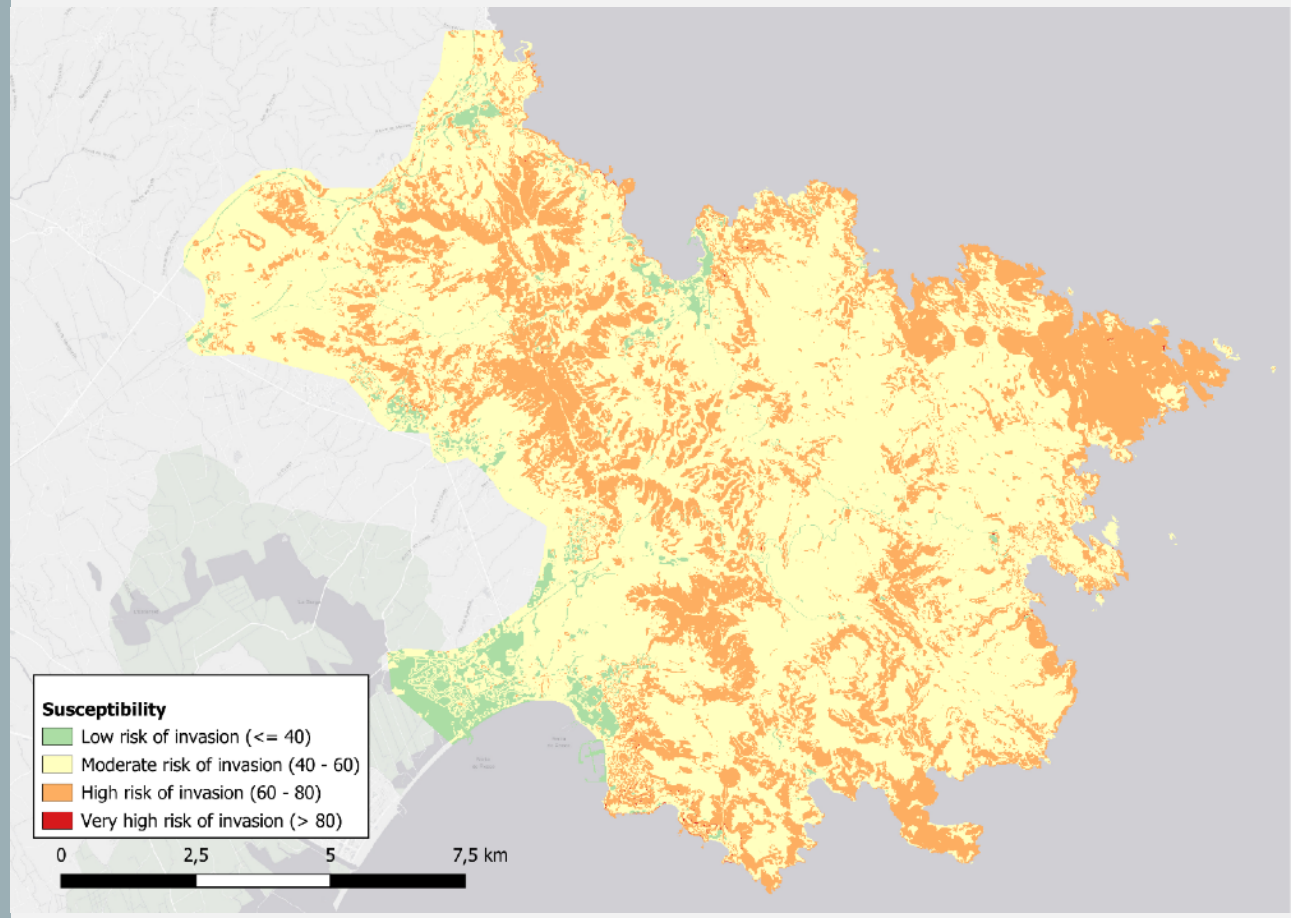
- Search spatial proxies represent them
- A classification is assigned, composed of several discrete and mutually exclusive states
- Each discrete state is assigned a risk value [0 to 100]

EXAMPLE

Risk factor & definition	Spatial proxy	Classification of spatial attributes in discrete states	Risk value
Minimum temperature If the plants are exposed to adverse minimum temperatures during the coldest month of the year	BIO6 = Minimum temperature of the coldest month	Optimum: >3ºC	100
		Suitable: ≤ 3ºC and > -5ºC	50
		Not suitable: ≤ -5ºC	0

RISK MAPS

LAND MANAGEMENT WITH RISKMAPR



STEP 4. LINK SPATIAL DATA

EXAMPLE

Risk factor & definition	Spatial proxy	Classification of spatial attributes in discrete states	Risk value
Minimum temperature If the plants are exposed to adverse minimum temperatures during the coldest month of the year	BIO6 = Minimum temperature of the coldest month	Optimum: >3ºC	100
		Suitable: ≤ 3ºC and > -5ºC	50
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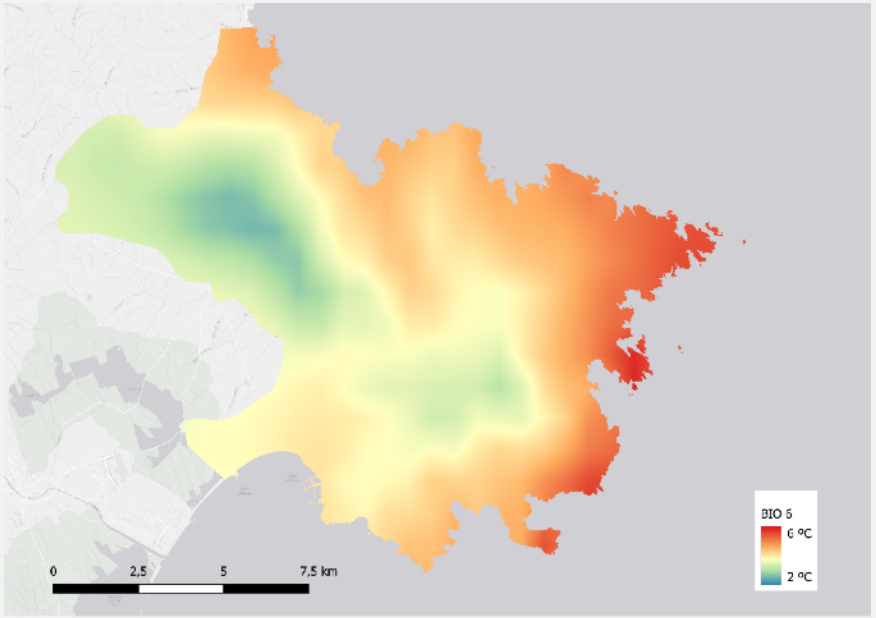
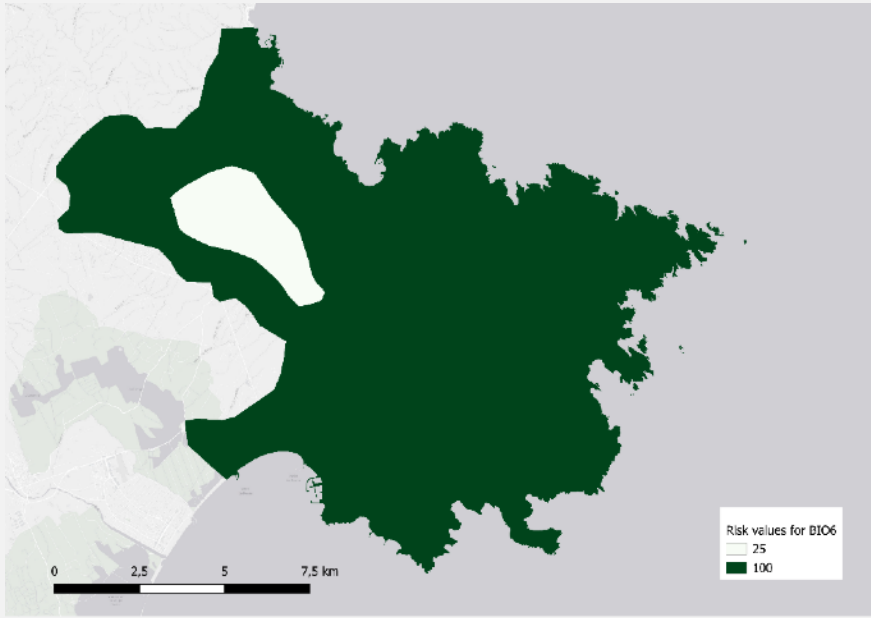


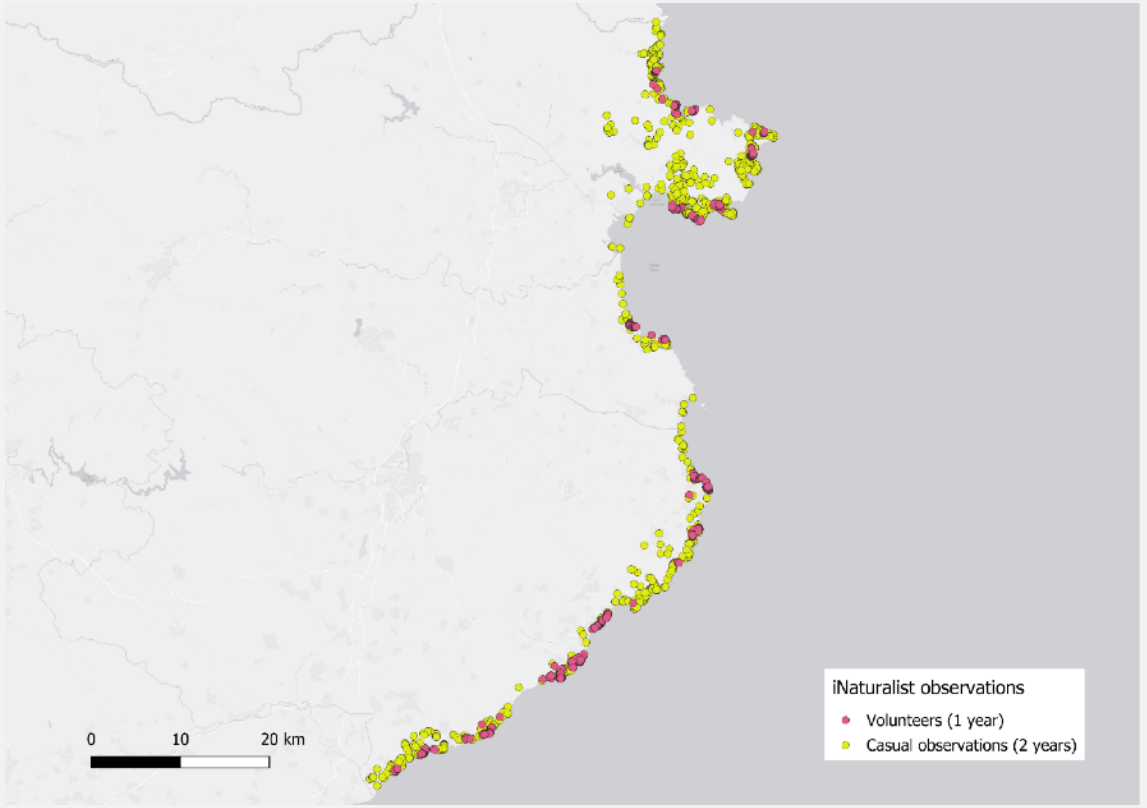


STEP 5. PROPAGULE SUPPLY AND DISPERSAL MODELS

- To create the propagule pressure maps:
  - Supply of propagules
  - Dispersal over short or long distances (animals, wind, water, etc.)

- "Riskmapr" features a functionality to generate propagation and dispersion pressure maps using species location data and additional information

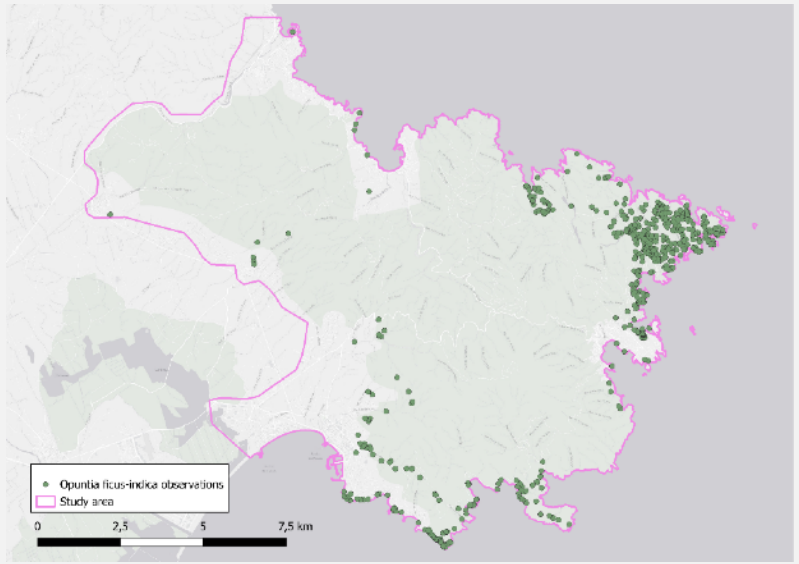
- Data from a volunteer network and casual observations collected via the iNaturalist provides up-to-date data on the presence of invasive plants

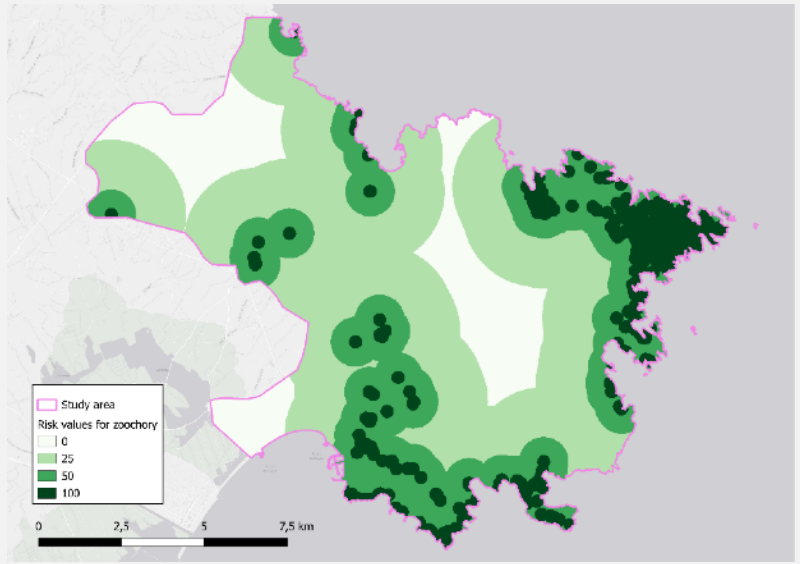


STEP 5. PROPAGULE SUPPLY AND DISPERSAL MODELS

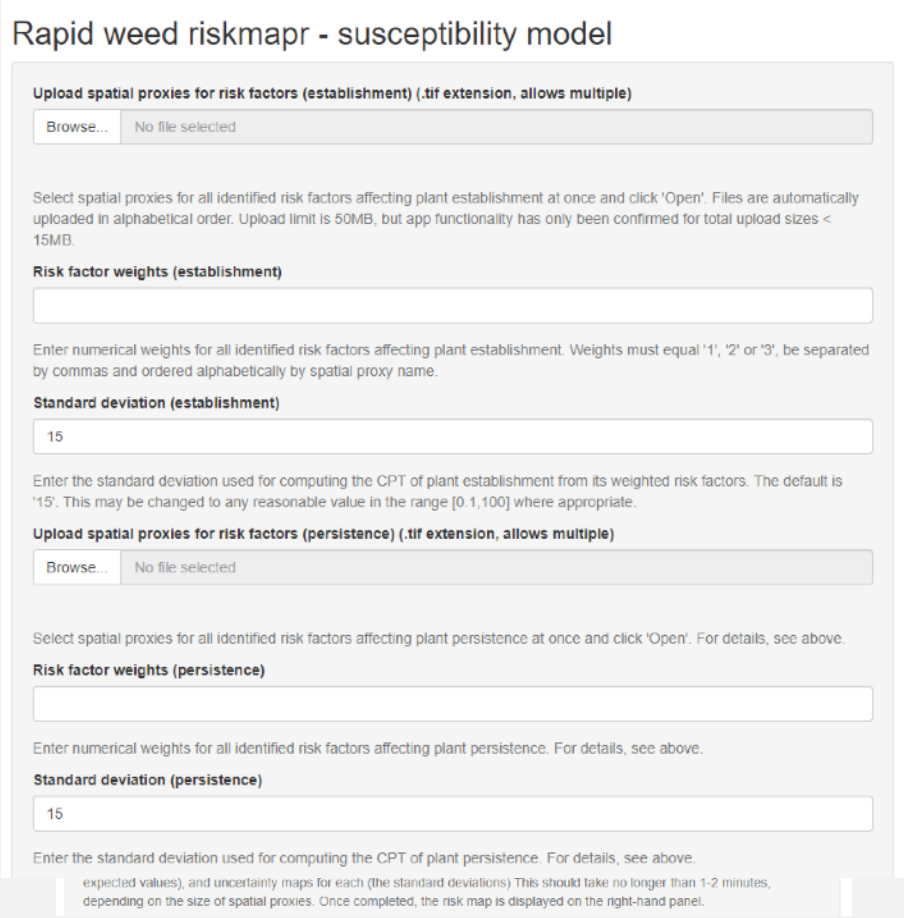
EXAMPLE

Risk factor & definition	Spatial proxy	Classification of spatial attributes in discrete states	Risk value
Animal dispersal (epi- / endozoochory) Frequency and density of dispersed segments of source populations by terrestrial and flying animals	Map derived from the observations of volunteers and observers on the iNaturalist platform	Radial Euclidean distance calculated from the nearest source	
		Optimum : 0 to 200 m	100
		Moderate : 200 to 750 m	75
		Not suitable : 750 to 2250 m	25
		Unsuitable : > 2250 m	0



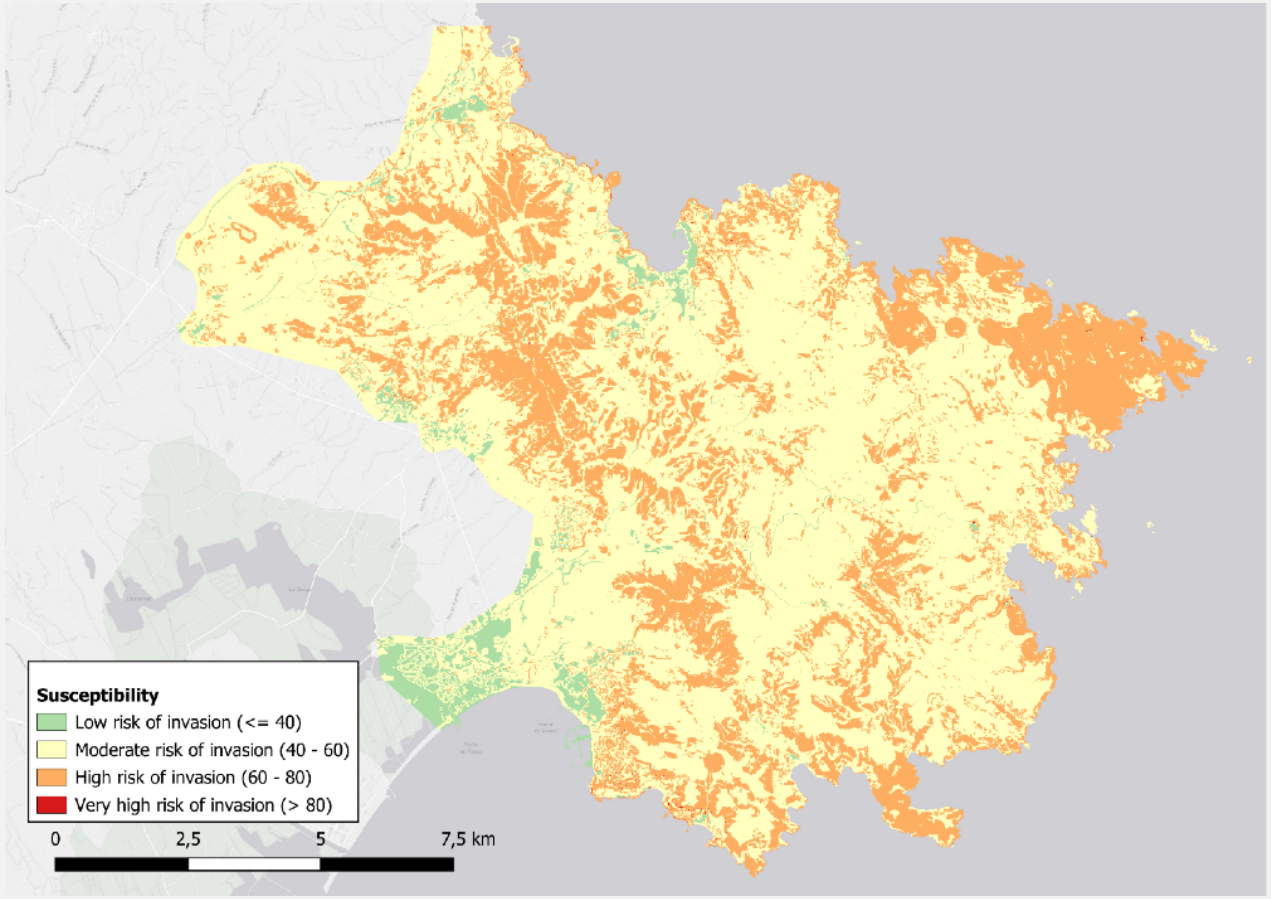


STEP 6. CREATE RISK MAPS WITH " RISKMAPR "



- Use the RISKMAPR application for the invasive plant (ex: *O. ficus-indica)*
- **Inputs:**
  a. Maps of each risk factor associated with the models of each plant
  b. Weighting of risk factors [1,3]
  c. Standard Deviations (SD)
- **Outputs:**
  a. Concept map of the model
  b. "Suitability" and "Susceptibility to Invasion" Index Maps
  c. Uncertainty maps of for the two maps above

RESULTS RISKMAPR

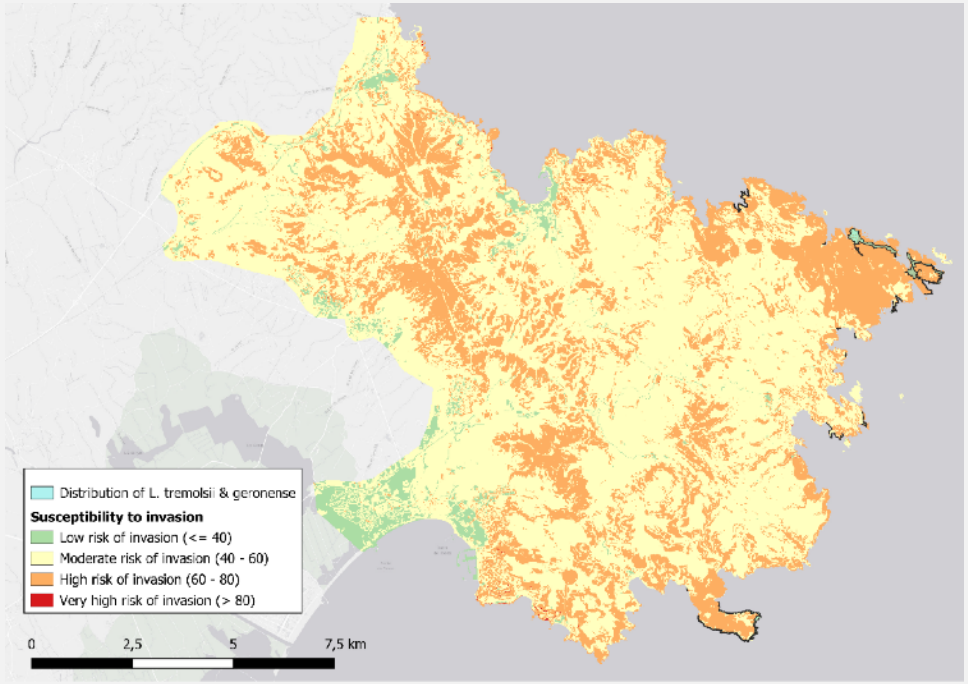


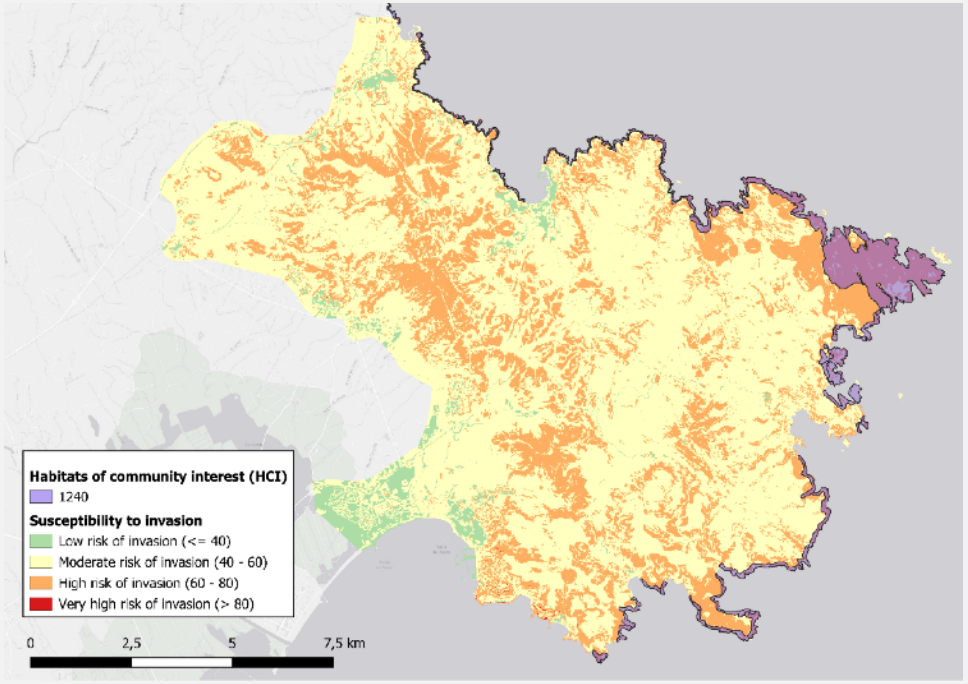
Susceptibility of the territory to an invasion (ex: *Opuntia ficus-indica*)

- Know the state and general risk of invasion by an invasive plant
- Useful for predicting where the invasive plant will spread
- Where to focus efforts to eradicate or contain the invasive species

PRACTICAL FUNCTION OF RISK MAPS

- Overlapping data on the distribution of species or habitats that want to be protected to find the priority areas for eradication or containment





CONCLUSIONS

- The results you have seen are preliminary (limited study area and species in an advanced invasive state)
- The use of citizen science has potential to target larger areas and a wider range of species
- The application is an innovative tool that allows to:
  - Balance ecological complexity with the practical needs of land managers
  - Minimize long-term cost management and impacts

THANK YOU

- If you want more information about our project:

  www.lifemedcliffs.org

- Or reach us to:

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