Endemic Plant Distribution in Majella National Park, Italy

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March, 2010

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by

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Thesis submitted to the International Institute for Geo-information Science and Earth Observation in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation, Specialisation: Natural Resource Management

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Abstract

Majella National Park is in the Mediterranean biodiversity hotspots. Its abounding plant and animal resource attracted many researches to come for plant researches, animal researches, topographic researches, climate change researches and others. However, due to the weather, human and short flowering-period limitation, the clear and complete endemic plant taxa geodatabase is still absent, that also causes the distribution of endemic plant taxa is debated. The object of this research is to contribute an understanding of the endemic plant taxa plant distribution in Majella National Park.

Because of the limitation of the field work, this research used secondary data from "Data Base Della Flora Vascolare Del Parco Nazionale Della Majella" (Database of the vascular flora of Majella National Park), "Index Seminum" (Index of seed collection) and the research of Romeo Di Pietro in 2008. After pre-processes in ArcGis and ERDAS, a consistent geodatabase was built. In this geodatabase the 4 levels spatial accuracy system of Fabio Conti's database was used. Considering the spatial accuracy, only the records with level-one and level-two spatial accuracy were used. The resolution of environment parameters was reduced in order to associate with the geodatabases, so cell size was increased to 1Km.

This geodatabase is a presence-only geodatabase, and modelling methods were limited. In order to overcome this,the procedures of predicting the distribution maps are data preparing, predicting habitat-suitability maps and predicting distribution maps. Predicting habitat-suitability maps was taken in BioMapper, and predicting distribution maps was taken in the R statistical computing environment with geostatistics (gstat package).

The geodatabase shows there are 146 endemic plant taxa in Majella national park, and 70% of them are rare taxa in the world. There are 10 endemic plant taxa selected for further analysis. Though the habitat-suitability model, it shows elevation and NDVI are the best explanatory environmental parameters, and most of endemic plant taxa tend to grow in the high elevation part and open vegetation. Comparing the results of habitat-suitability maps from ENFA and distribution maps from Indicator kiging, in the core habitat the result is similar, but in other parts the habitat-suitability maps seem to be a too optimistic prediction. However, large geodatabases are required to confirm the distribution pattern and its reasons.

Acknowledgements

I sincerely thank my supervisors, Dr. Hein van Gils and Dr. David Rossiter, who always supported me in my research period. I deeply appreciate the excellent suggestions and wonderful discussion. Because of my two coaches, I really enjoy the time when I was conducting this research. Thanks to all professors in ITC. During this almost two years I learned more than I expected.

Spatial thanks to Dr. Eduard Westinga and Dr Anton Vrieling for the help during the field work. I also would like to thank the staffs of Majella National Park for the help during the field work, especially to Dr. G. Ciaschetti. I would like to thank Dr. Fabio Conti. Without his contribution of geodatabase, this research can not be finished.

I would like to thank all classmates in NRM 2008. I like you guys. Special thank to Arinta, Joon, Fuad, Sigi, Juan Pablo, NGA, Simona and Denial. Also thanks to Li for her accompanying in the research period. The great gratitude to my Taiwanese friends, and I really appreciate the laughing time and the travelling time, especially to Chou-Yen, the Tsaos. With all of you, I really enjoy my big journey in NL.

Lastly, my heartfelt appreciation goes to my dear family. Without my parent s' supports, I can not write this thesis here. Thanks to my sister. Let me can only concentrate to my study. Also thank to Mr. Chen. I will arrive home soon.

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1. Introduction

1.1. Background and Significance

Biodiversity conservation is an important issue (Convention on Biological Diversity, 2007). Endemics are an essential component of biodiversity (Myers, et al., 2000).

1.1.1. Biodiversity

"Biodiversity" was defined narrowly in the 1980s as the number of species in a signal area (Allaby, 2005; Swingland, 2001). Recently, the concept of "Biodiversity" has been widened to include species diversity, genetic diversity, and ecosystem diversity (Smitinand, 1995; Swingland, 2001). The Convention on Biological Diversity (2007) defines biodiversity as "The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

How to preserve biodiversity and how to enhance biodiversity are two popular issues, because an ecosystem with a higher plant biodiversity can product more benefit (Heal, 2001). The value of plant biodiversity can be divided into two categories; economic benefits and physical functions. Economic benefits are food, medicine and industrial raw materials; physical functions are providing different kinds of habitats for animals and plants and essential services to human (Smitinand, 1995).

1.1.2. Biodiversity Hotspots

Conservation work is limited by funding and work load. Therefore, it is necessary to build a method for preserving most species including endemic species at the least cost. Because of these physical limitations, biodiversity hotspots can be considered as a good guide for conservation work(Myers, et al., 2000). Biodiversity hotspot means an area rich in species, rare species, threatened species and species which combines these attributes (Reid, 1998). There are two criteria to identify a hotspot. The first one and also the main one is species endemism. The other is degree of threat (Myers, 2001).

1.1.3. Plant biodiversity in Majella National Park

At the global scale there are 25 hotspots (Myers, et al., 2000). The biggest hotspot is "Tropical Andes" which includes 45,000 plant species. These plant species are 6.7% endemic plant species of the world.

“Sundaland” is the second biggest hotspot, and there are 25,000 plant species which are 5.0% endemic plant species of the world. The “Mediterranean basin” is the third biggest hotspot. In this hotspot there are 22,500 plant species, and half of these plant species are endemic (McManus, 2010; Myers, et al., 2000). Majella National Park is not consider as hotspots in the Mediterranean basin (Medail & Quézel, 1999). This statement has to be queried because Majella National Park has a high plant biodiversity (> 3000 plant taxa) and 146 endemic plant taxa (Majella National Park, 2009).

1.2. Research Problem

In order to model endemic plant distributions, the first research requirement is clear and complete endemic plant taxa geodatabases. This research used secondary data from “Data Base Della Flora Vascolare Del Parco Nazionale Della Majella” (Database of the vascular flora of Majella National Park), “Index Seminum” (Index of seed collection) and the research of Romeo Di Pietro in 2008.There are some problems about the consistent data frame, the spatial accuracy and plant taxa nomenclature in different sources.

Further, the reason for the distribution of endemic plant taxa is debated. Most of endemic plant taxa live above timberline (Pietro, et al., 2008). This is an interesting issue about the plants which grow in a strict environment. Because of their special growing quality and the rare population, it is not easy to understand through experiment.

Furthermore, at the Mediterranean-basin scale it is queried whether Majella National Park is an endemic plant biodiversity hotspot or not. It has to be proven that Majella National Park has high endemic plant taxa richness and has high potential for supporting high endemic plant taxa richness.

1.3. Research Objective

The overall objective of this research is to contribute an understanding of the plant biodiversity and to indentify biodiversity hotspots in Majella National Park, with the following specific objectives:

1) To build a clear and complete endemic plant taxa geodatabase.

2) To model the endemic plant taxa suitable habitat.

3) To model the selected endemic plant taxa distribution with presence-only data.

1.4. Research Question

Based on the research objective, the research questions are built below.

1) To build a clear and complete endemic plant taxa geodatabase

- What are the limitations of this database built from secondary data? And can these limitations be solved by technical methods?

- Which level of spatial accuracy records should be used in this research?

2) To model the endemic plant taxa suitable habitat.

- Which environmental parameter affects the distribution of endemic plant taxa more?

3) To model the selected endemic plant taxa distribution with presence-only data.

- How is the distribution map modelled with presence-only data?

1.5. Hypotheses

Hypothesis 1

The limitations of this database built from secondary data can be solved by technical methods.

Hypothesis 2

Only level- one and level- two of spatial accuracy records are good enough to be used for analysis.

Hypothesis 3

Distribution of endemic plant taxa can be predicted from acceptable model (threshold > 0.5) with ENFA.

Hypothesis 4

Elevation and NDVI are the most explanatory environmental parameter.

2. Literature Review

2.1. Using Presence-only Data to Predict Species Distribution

There are many computational frameworks to predict species distributions from geodatabases and environment parameters. In general, these frameworks can be classified into two categories by the requirement of geodatabases: methods that need presence-absence data and methods that use presence-only data (Tsoar, et al., 2007). Presence-only data can not contribute information on locations where the species is absent (Perce & Boyce, 2006). It will happen when the objective species is not easy to observe because the animal moves too fast or travels through too big ranges, or the plant is rare or endanger. It also happens when the database is built without well sample schemes or secondary databases from herbarium or museums are used (Engler, et al., 2004).

In order to predict species distribution maps with presence-only data, many analytical approaches have been used, e.g. BIOCLIM, HABITAT, Mahalanobis distance method, DOMAIN, Ecological Niche Factor Analysis (ENFA), GARP, Maxent, et al (Hengl, et al., 2009; Hirzel, et al., 2002; Perce & Boyce, 2006; Tsoar, et al., 2007; Zaniewski, et al., 2002). Pearce (2006) classified these approaches to 4 kinds, and they are:

1) Describing the distribution of the presence-only records.
2) Contrasting the distribution of presence records with that of pseudo-absences.
3) Contrasting the distribution of presence records and available sites.
4) Modelling abundance when abundance given presence is known.

The different between the second kind of modelling approaches and the third is a bit. The second kind is to consider used or consumed resource cells, and the objected species is present or truly absent in a cell. Modelling the distribution of plant is a good example. The objective of these researches is to predict species distribution maps (Engler, et al., 2004; Hengl, et al., 2009; Phillips, et al., 2006; VanDerWal, et al., 2009; Zaniewski, et al., 2002). In order to generate less bias or suitable pseudo-absences record, some research (Engler, et al., 2004; Hengl, et al., 2009) use ENFA to predict habitat-suitability maps first, and then pseudo-absences records are generated from the proportion of habitat-suitability.

The third kind is often applied in wide-ranging animals (Frair, et al., 2004), and all resource cells are assumed to be available to be used. Every cell is considered to be available to the species of interest and potentially used (Perce & Boyce, 2006). Because the field works of plant are much easier to get present/absent geodatabase than the field work of animals, the researches with presence-only data of animals is much more than the research of plant (Hirzel, 2005). The objective of these researches is protection and choosing reserve sites (Bayliss, et al., 2005; Braunisch, et al., 2008; García, 2006; Hirzel, et al., 2002; Tole, 2006).

2.2. Ecological Niche Factor Analysis (ENFA)

ENFA is an approach to compute suitability function with environment parameters (Hirzel, et al., 2002). This method is based on analysis the grids of presence-only records and the grids of environmental parameters and also comparing these grids with other grids in global (Pearce & Boyce, 2006). For comparing the environmental parameters grids of present data with other grids, the marginality (M) and specialisation (S) are computed. Marginality is expressed by the fact that the species mean differs from the mean of global. Specialisation is expressed by the fact that the species variance is lower than the global variance. The formula of marginality (M) and specialisation (S) are shown below:

$$M = \frac{|m_G - m_S|}{1.96\sigma_G}$$

m_G = the mean of global

m_S= the mean of species

$$S = \frac{\sigma_G}{\sigma_S}$$

σ_G = the standard deviation of the global distribution

σ_S = the standard deviation of the species distribution

3. Research Materials

3.1. Study Area

The study area is in Majella National Park, Abruzzo, Italy (latitude 41°52’ to 42°14’ N. longitude 13°50’ to 13°14’ E)(Fig. 3-1). This park is in the central Apennines. Mount Amaro (2,794 m a.s.l.) is the highest mountain in the Majella massif. Majella massif is the major part in the Majella National Park. Its average altitude is higher than the average altitude of Gran Sasso, the highest peak in the Apennine chain. Even it has the area of $11Km^2$ above 2,500 m. Majella massif is famous for its peak with compact shape and a flat alpine pasture, and its border is steep slope, incised by deep valley (Blasi, et al., 2005; Stanisci, et al., 2005). This unique topography supports unique habitat for endemic plants. Therefore, Majella National Park not only has significant plant richness but .also has various rare plant taxa (Stanisci, et al., 2005). There are more than 3000 plant taxa, and more than 142 plant taxa are endemic plant taxa of Italy (Majella National Park, 2009).

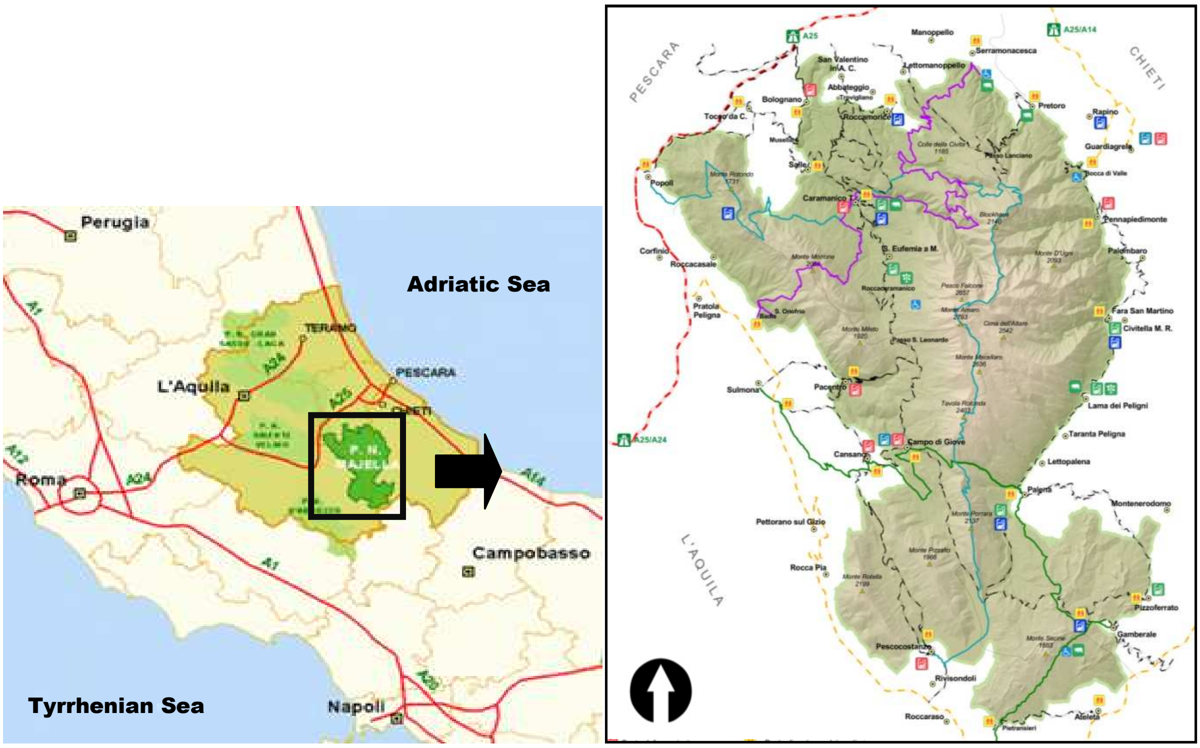

Fig. 3-1 The location of Majella National Park (Modified from Majella National Park, 2009)

3.2. Database

In order to generate endemic plant taxa distribution maps, endemic plant taxa geodatabases and related environmental parameters are needed. "Flora d'Italia" (Pignatti, 1982) states that more than 80 taxa and rare in the 146 endemic plant taxa of Italy. Apart from this, 18 endemic plant taxa can grow above the timberline (1800m). Consequently, generating the geodatabase by a systematic survey (or census) is difficult because of inaccessibility of the terrain, time consuming and therefore costly. Therefore, this research used secondary geodatabase in multi-sources for predicting the endemic plant distribution. These geodatabases do not have consistent format and do not have sufficient spatial accuracy. The process of dealing with the geodatabases and environmental parameters are explained below.

3.2.1. Endemic plant taxa geodatabases

There were four sources of endemic plant taxa geodatabases so building a consistent data frame and plant taxa nomenclature was a key process of this research. Furthermore, to define the spatial accuracy is also important for the later analysis work. This research consulted "Data Base Della Flora Vascolare Del Parco Nazionale Della Majella" (Database of the vascular flora of Majella National Park) to build the geodatabases. The code of taxa and the plant taxa nomenclature were adopted from "An Annotated Checklist of the Italian Vascular Flora" (Giovanna, et al., 2005). The definition of spatial accuracy was the same as "Data Base Della Flora Vascolare Del Parco Nazionale Della Majella" and was classified into four levels. These four levels are:

- Level-one - the record has "exact" coordinates, determined by consumer-grade single receiver GPS.
- Level-two - the record only provides toponomy, and this can be easily assigned coordinates in an administrative area.
- Level-three - the record provides toponomy, but this toponomy cannot be easily assigned coordinates because its region crosses two or more than two administrative areas.
- Level-four - the record only mentions the region, e.g. Majella, Majella National Park or Abruzzo; this latter includes the entire study area of this thesis.

3.2.1.1. Data Base of Vascular Flora of Majella National Park

The major part of collected data is in this geodatabase. This was contributed by Dr. Fabio Conti (interview 28-Sep-2009) and is a project of collecting all plant taxa records of Abruzzo. This research is only concerned with the endemic plant taxa in Majella National Park, so this geodatabase contains only a part of the Fabio Conti's geodatabase. From this geodatabase the list of the endemic plant taxa in Majella National Park and their records were extracted. This geodatabase has two sources: bibliographic and herbarium records (Conti & Tinti, 2006), and it lists 146 endemic plant taxa in Majella National Park.

The geodatabase from bibliographic records dates from 1811 to 2008. It was collated by Fabio Conti from all research, project reports, books and research literature of Abruzzo. The geodatabase accuracy is from level- two to level- four.

The geodatabase from herbarium records comes from three herbaria: Herbarium Appenninicum, Herbarium Neapolitanum and Herbarium Magellense (Conti & Tinti, 2006). The data accuracy is from level- one to level- four; however the level-one records are in geographic coordinates (Spheroid name: WGS 84, Datum name: WGS 84), which have been transformed to this research's common coordinate system (UTM Zone 33N, ED50 datum) with "Coordinator Calculator" tool in ERDARS. This data base of this research was cleaned with two steps. At the first, this data base was cleaned by the description of the location. The boundary of Majella National Park was used to confirm every record was in the Majella National Park. If there were records outside the boundary, these records were considered the description of the location and were moved to correct locations or were deleted when the locations were outside Majella National Park. Then, the data base was also cleaned by identifying duplicate records of the same species at the same assigned points and deleting one of them. Only level-one and level-two records were retained for this research. Level-four encompasses the whole study area and adds no location-specific information. Level-three can not contribute good spatial accuracy for this research.

3.2.1.2. Index Seminum (Index of seed collection)

These books were published by Majella National Park and recorded the seeds collected from two herbaria and from the field in Majella National Park between 2003 to 2008. The records contain the toponomy and elevation of each place where seeds were collected. This is equivalent to a level- two or level- three record. These records were assigned to coordinates (UTM Zone 33N, ED50 datum) and were defined special accuracy by consulting the geodatabases of "Data Base Della Flora Vascolare Del Parco Nazionale Della Majella" and the elevation information. This geodatabase was also cleaned by two steps. The first step was cleaning by confirming the records were in the Majella National Park. The second step was to identify duplicate records of the same species at the same assigned points and deleting one of them. Only level-one and level-two records were retained for this research.

3.2.1.3. The research of Romeo Di Pietro in 2008

Even though this literature (Pietro, et al., 2008) has already included in Fabio Conti's data base, the latter only recorded the toponomy at level-two special data accuracy. However, the original research paper gives geographic coordinates (Spheroid name: WGS 84, Datum name: WGS 84), and this research has transformed geographic coordinates to this research's common coordinate system (UTM Zone 33N, ED50 datum) with "Coordinator Calculator" tool in ERDARS. These were added to the data base of this research, and so the corresponding records in Fabio Conti's data base were deleted.

3.2.1.4. Flora d'Italia (Flora of Italy)

This book (Pignatti, 1982) contains the background of endemic plant taxa in Majella National Park. There are 146 endemic plant taxa in the park, but 15 of these have not been identified since the publication of the book. The background information on the remaining 131 taxa includes life-form, habitat, low-altitude, high-altitude, and flowering period. This database contributed the ecological information of plant taxa.

3.2.2. Environmental parameters

Because this research use level-one and level-two spatial accuracy records, the resolution of environment parameters has to be reduced in order to associate with the geodatabases (Engler, et al., 2004). So, cell size was increased size to 1Km, and Majella National Park boundary was used to define analysis area. Table 3-1 expresses all environmental parameters included in this research. The preparing process of each environment parameter is explained below.

3.2.2.1. Boundary

In order to make a boundary suitable for environmental parameters with 1Km resolution in ArcMap, the first procedure was to make shapefile as a polygon (Fig. 3-2). "Polygon to Raster" tool was used to make a boundary layer with 1Km resolution shape, and "elevation" with 1Km resolution was chosen to import the extent settings in the general settings of environmental settings for making every environmental parameter can be overlaid. The output cell size was set in 1000m. Then, the output raster file was changed to polygon with "Raster to Polygon" tool, and the "Simplify the polygon" was unchecked. The research area boundary with 1Km resolution was shown in Fig. 3-3.

3.2.2.2. Elevation

Elevation was generated from Digital elevation model (DEM) in the ArcMap (Fig. 3-4). There were only two procedures. Reducing the resolution to 1Km is the first one, and "Resample" tool was used.

Then, “Extract by Mask” tool was used to make elevation only within Majella National Park, and the boundary with 1Km resolution shape was used as a mask. The elevation with 1Km resolution was shown in Fig. 3-5.

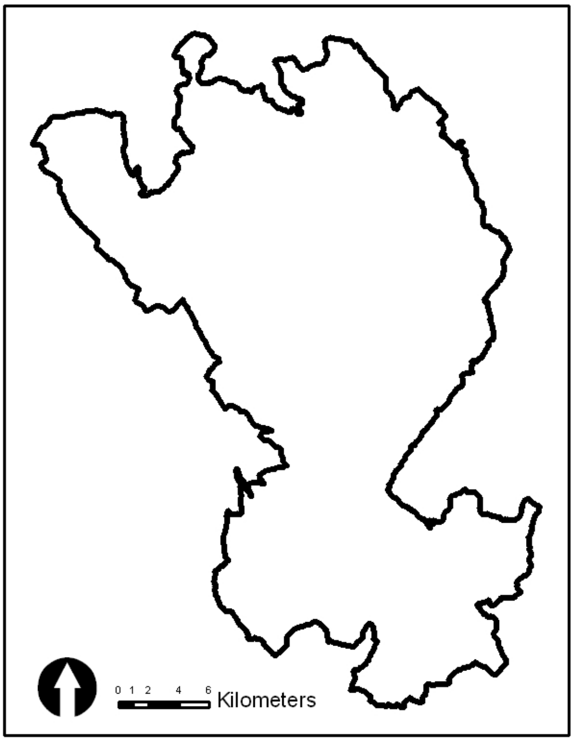

Fig. 3-2 Boundary

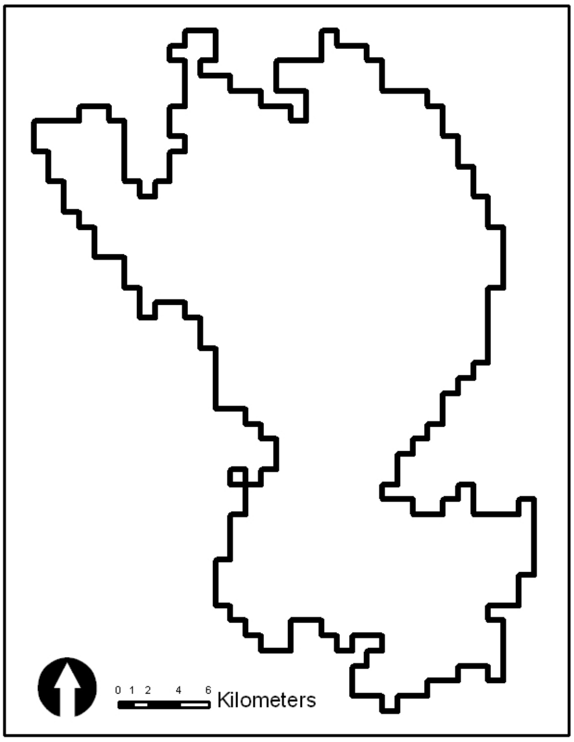

Fig. 3-3 Boundary with 1Km resolution

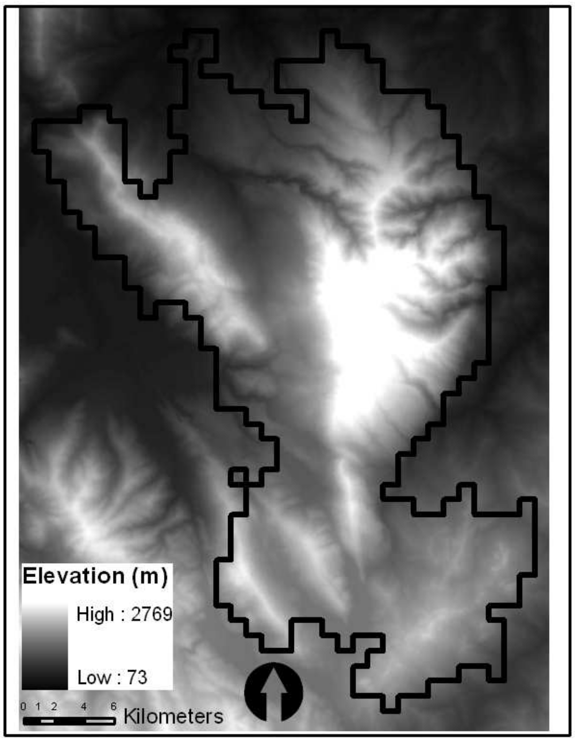

Fig. 3-4 Elevation

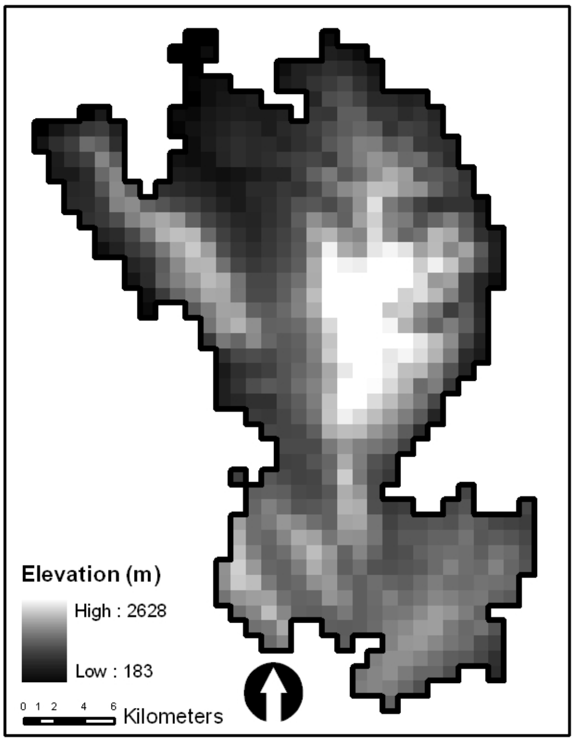

Fig. 3-5 Elevation with 1Km resolution

3.2.2.3. Incoming spring solar radiation

Incoming spring solar radiation was generated from DEM in the ArcMap. "Area Solar Radiation" tool was used to calculate the incoming spring solar radiation in the period of 1st April, 2010 to 30th April, 2010 (Fig. 3-6). Then, "Resample" tool was used to reduce the resolution from 30m to 1Km, and "elevation" with 1Km resolution was chosen to import the extent settings in the general settings of environmental settings. Then, "Extract by Mask" tool was used, and the boundary with 1Km resolution shape was used as a mask. Fig. 3-7 shows incoming solar radiation with 1Km resolution.

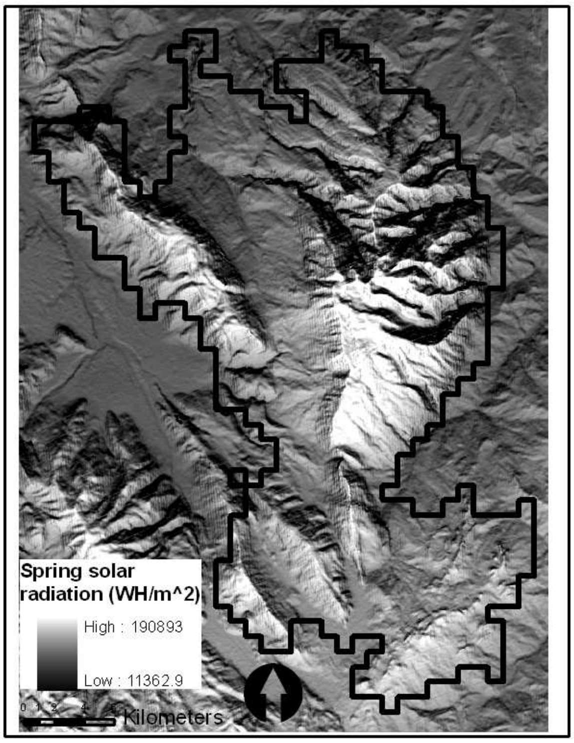

Fig. 3-6 Incoming spring solar radiation

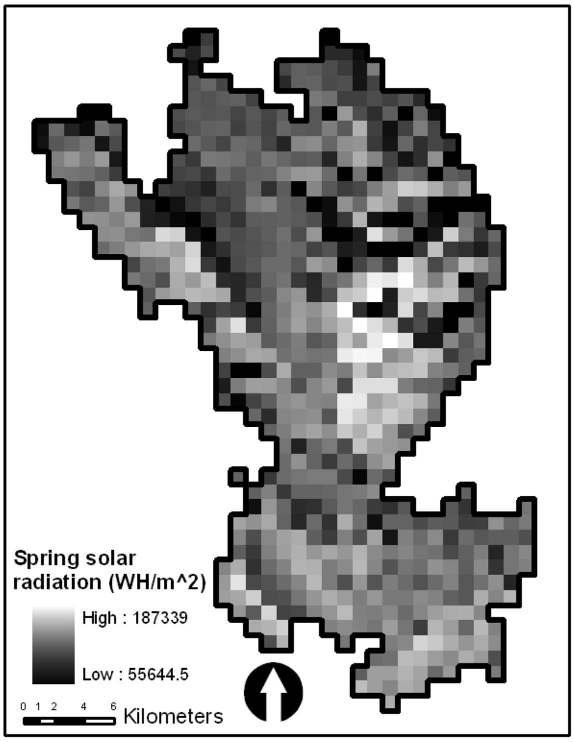

Fig. 3-7 Incoming spring solar radiation with 1Km resolution

3.2.2.4. Incoming summer solar radiation

Incoming summer solar radiation was generated from DEM in the ArcMap. "Area Solar Radiation" tool was used to calculate the incoming spring solar radiation in the period of 1st July, 2010 to 30th August, 2010 (Fig. 3-8). Then, "Resample" tool and Extract by Mask" tool were also used to generate incoming summer solar radiation layer (Fig. 3-9).

3.2.2.5. Incoming annual solar radiation

Incoming annual solar radiation was generated from DEM in the ArcMap. "Area Solar Radiation" tool was used to calculate the incoming spring solar radiation in the period of 1st January, 2010 to 30th

December, 2010 (Fig. 3-10). Then, “Resample” tool and ”Extract by Mask” tool were also used to generate incoming annual solar radiation layer (Fig. 3-11).

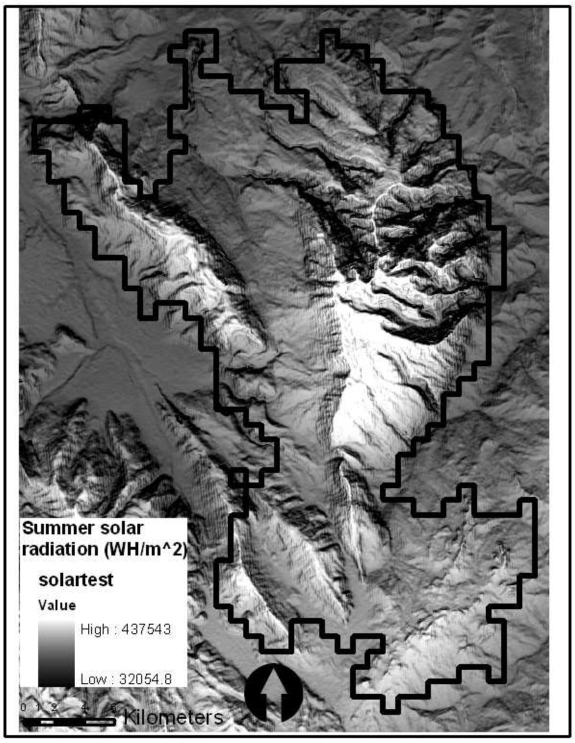

Fig. 3-8 Incoming summer solar radiation

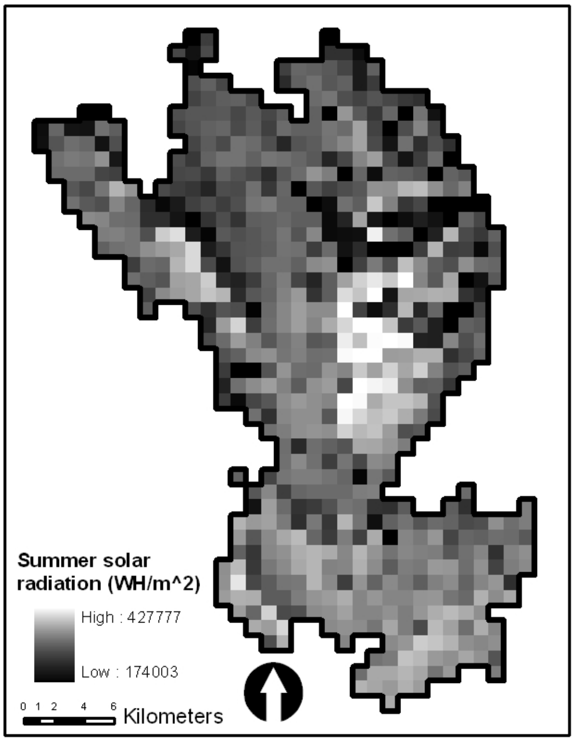

Fig. 3-9 Incoming summer solar radiation with 1Km resolution

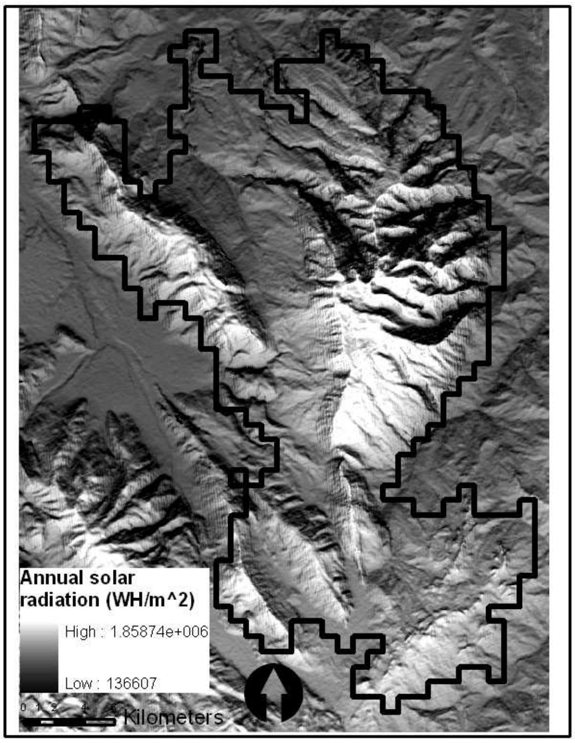

Fig. 3-10 Incoming annual solar radiation

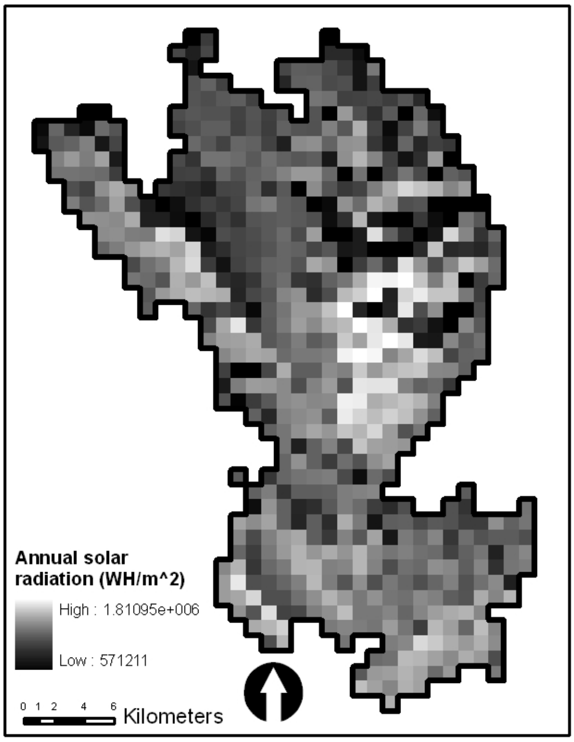

Fig. 3-11 Incoming annual solar radiation with 1Km resolution

3.2.2.6. Slope

Slope was generated from DEM with “Spatial Analysis Tools” in the ArcMap (Fig. 3-12), and “elevation” with 1Km resolution was chosen to import the extent settings in the general settings of environmental settings. Then, “Extract by Mask” tool was used, and the boundary with 1Km resolution shape was used as a mask (Fig. 3-13).

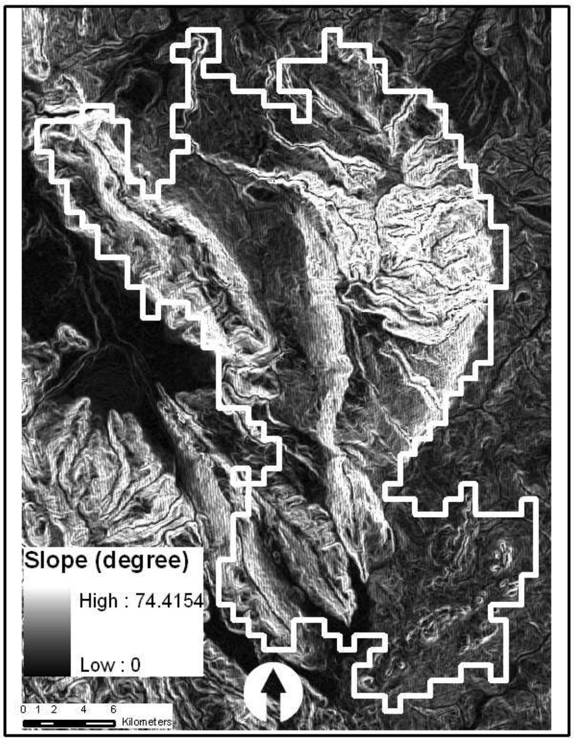

Fig. 3-12 Slope

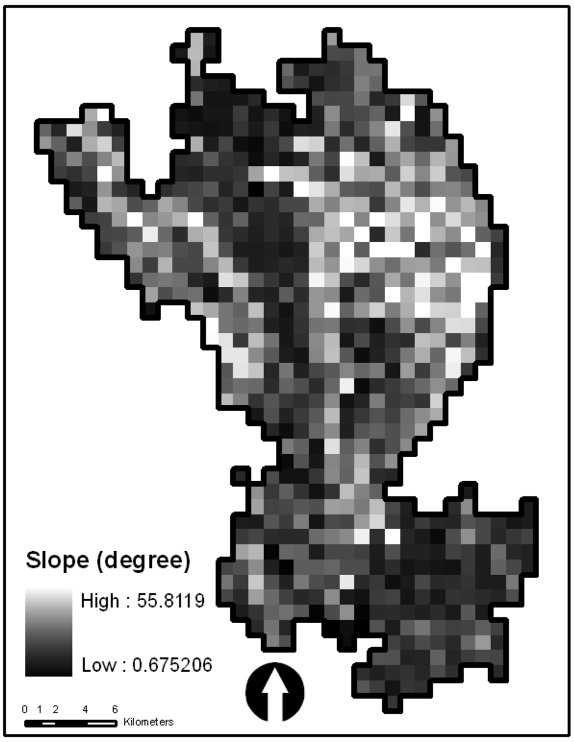

Fig. 3-13 Slope with 1Km resolution

3.2.2.7. Aspect

Aspect was also generated from DEM with “Spatial Analysis Tools” in the ArcMap (Fig. 3-14), and “elevation” with 1Km resolution was chosen to import the extent settings in the general settings of environmental settings. Then, “Extract by Mask” tool was used, and the boundary with 1Km resolution shape was used as a mask (Fig. 3-15).

3.2.2.8. Normalized Difference Vegetation Index (NDVI)

NDVI was generated from Aster image (27th May, 2008) in ERDAS with “Indices” tool in the “Spectral Enhancement” category. The formula of computing NDVI from ASTER image is:

$$\mathrm{NDVI} = \frac{(\text{Near IR band} - \text{R band})}{(\text{Near IR band} + \text{R band})} = \frac{(\text{Band3} - \text{Band2})}{(\text{Band3} + \text{Band2})}$$

Fig. 3-16 is the result of computing and shows the NDVI image in research area. This parameter still needed to be reduced resolution to 1Km with “Resample” tool in ArcMap, and “elevation” with 1Km resolution was chosen to import the extent settings in the general settings of environmental settings. Then, “Extract by Mask” tool was used, and the boundary with 1Km resolution shape was used as a mask (Fig. 3-17).

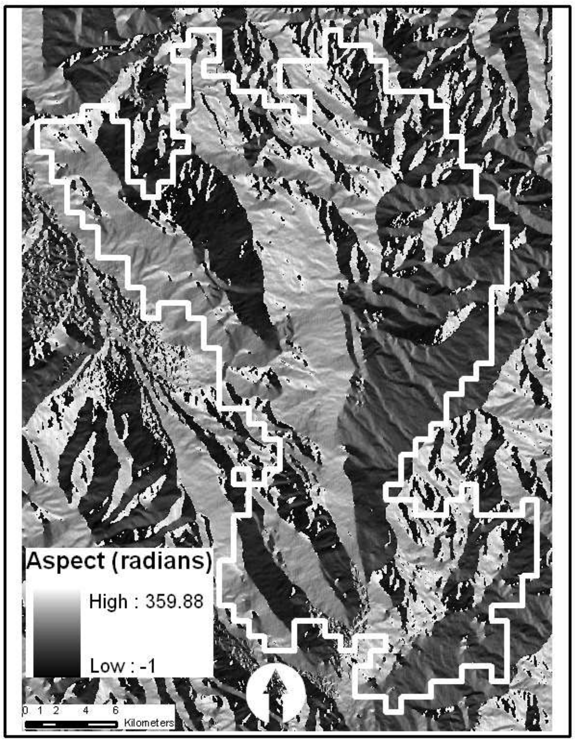

Fig. 3-14 Aspect

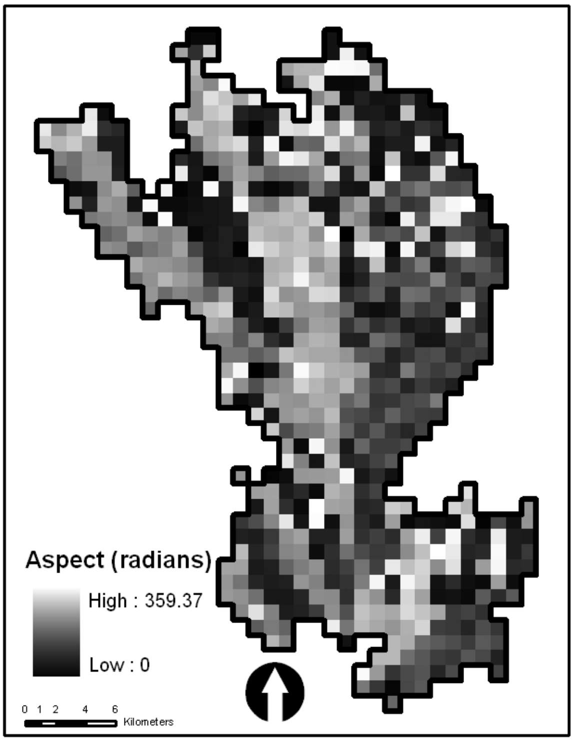

Fig. 3-15 Aspect with 1Km resolution

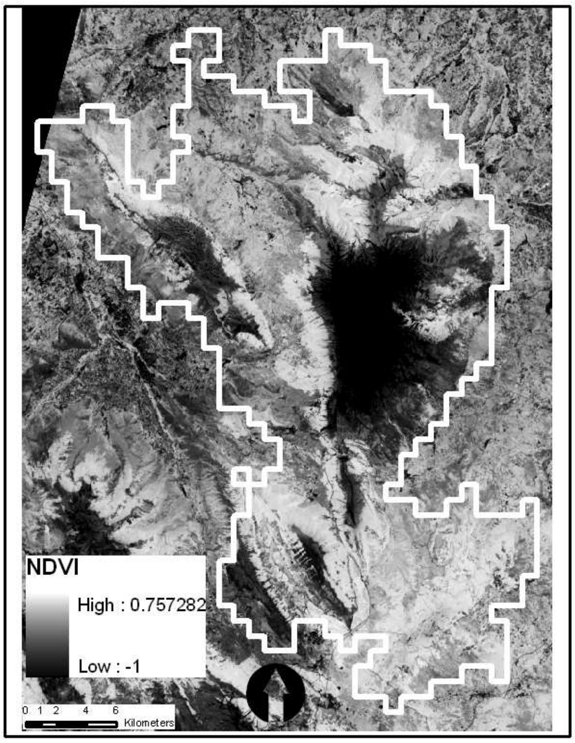

Fig. 3-16 NDVI

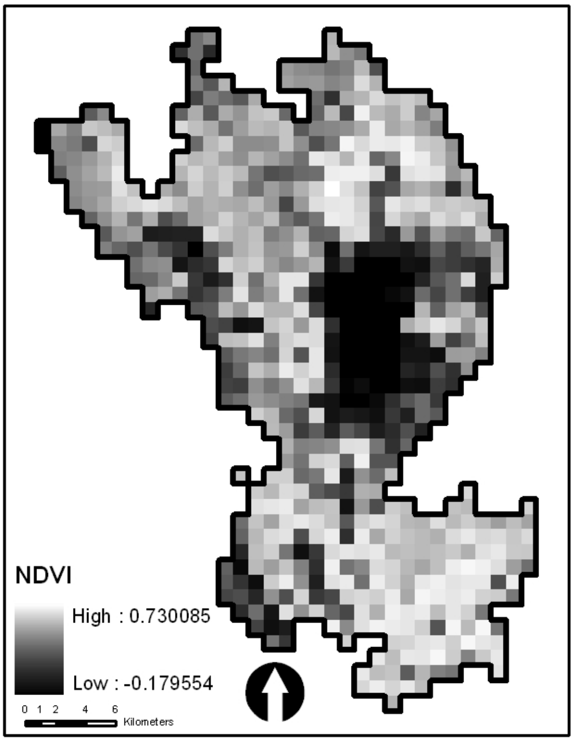

Fig. 3-17 NDVI with 1Km resolution

3.2.2.9. Topographic Position Index (TPI)

TPI was also generated from DEM with extensions "Topography Tools for ArcGIS" (Dilts, 2009) in ArcMap. The value of TPI is from negative 1 to positive 1. The value of negative 1 means the topography is valley, and the value of positive one means the topography is ridge (Enterprises, 2006). Fig. 3-18 express the meaning of the value of TPI and its landform type. When TPI was calculated, "elevation" with 1Km resolution was chosen to import the extent settings in the general settings of environmental settings, and also 1Km resolution was set in the raster analysis settings of environmental settings. Then, "Extract by Mask" tool was used, and the boundary with 1Km resolution shape was used as a mask.

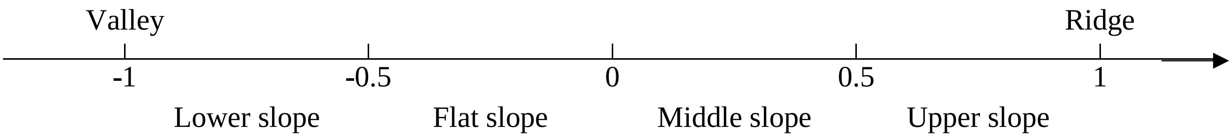

Fig. 3-18 The value of TPI and its landform type (Enterprises, 2006)

3.2.2.10. Landcover type

Landcover was generated from ALOS image (20th July, 2007) and was a categorical data. The supervised classification was used in ERDAS, and the Landcover map in 1999 from Majella National Park was used as a guide. It was classified into six classes: bare rock, crop field, grass/pasture, pine, shrub, and forest (Fig. 3-19). In order to change to 1Km resolution, the classified image was converted to raster image with "Raster to Polygon" tool in AcrMap. In the general settings of environmental settings "elevation" with 1Km resolution was chosen to import the extent settings, and also 1Km resolution was set (Fig. 3-20).For the further analysis, this categorical data has been transformed to six Boolean maps. It means each class was a Boolean map. In each Boolean map "1" means this kind of landcover happens in that grid, and "0" means this kind of landcover does not happens in that grid.

3.2.2.11. Soil type

Soil type was created from the existing digital soil map from Majella National Park and was a categorical data. The soil type 1 was used in this research. There are 4 types, and they are Continental deposits, Marine sediments, Terrestrial sediments deposits and Limestone and marls (Fig. 3-21). This image was also converted to raster image with 1Km resolution and the same extent setting (Fig. 3-22). Furthermore, this soil type data has also been transformed into 4 Boolean maps.

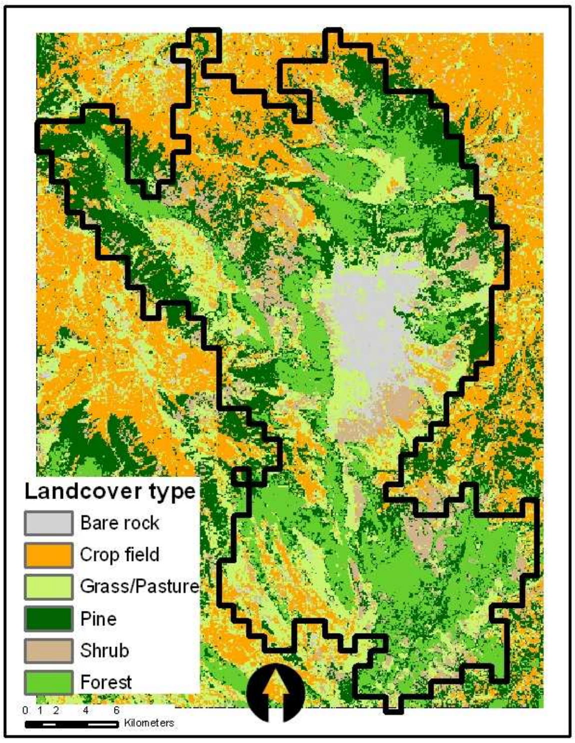

Fig. 3-19 Landcover type

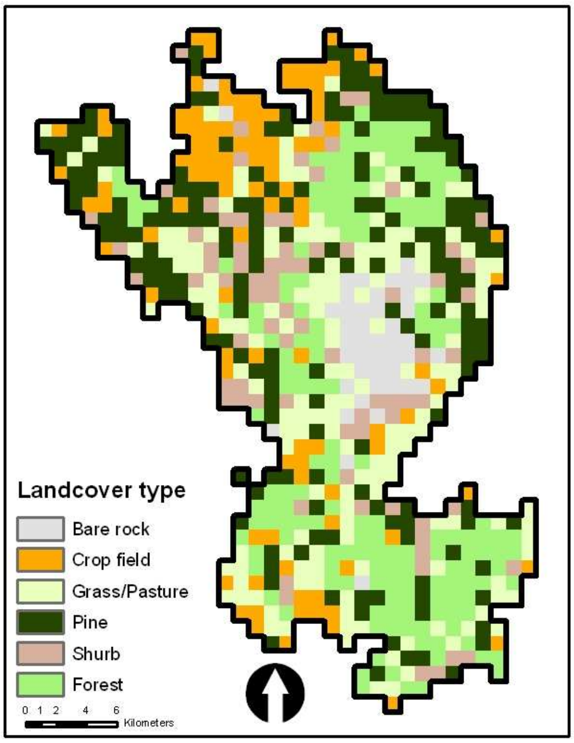

Fig. 3-20 Landcover type with 1Km resolution

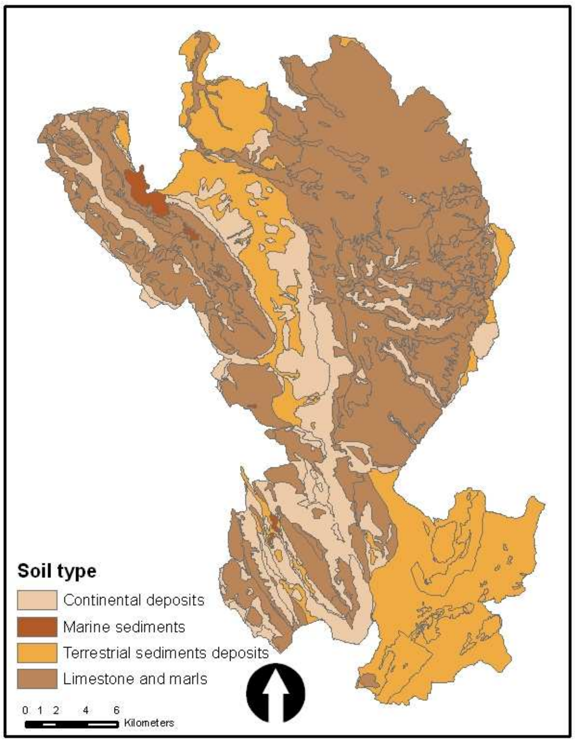

Fig. 3-21 Soil type

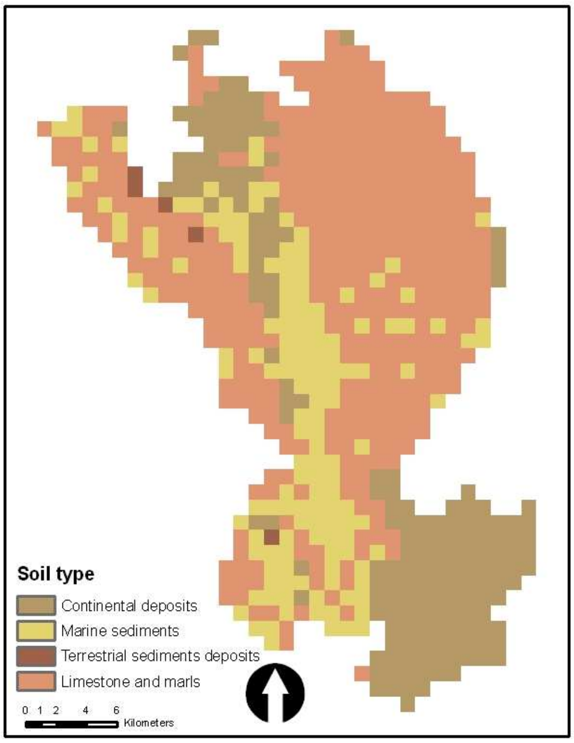

Fig. 3-22 Soil type with 1Km resolution

Table 3-1 Environmental parameters included in this research

Environmental parameter	Data type	Year	Data source		Original	
					Data type	Resolution/Other
Boundary 1Km × 1Km	Vector file		Majella National Park	Boundary	Vector file	Shapefile - line
Elevation	Raster file	2008	ASTER	DEM	Raster file	30m × 30m
Incoming spring solar radiation	Raster file	2008	ASTER	DEM	Raster file	30m × 30m
Incoming summer solar radiation	Raster file	2008	ASTER	DEM	Raster file	30m × 30m
Incoming annual solar radiation	Raster file	2008	ASTER	DEM	Raster file	30m × 30m
Slope	Raster file	2008	ASTER	DEM	Raster file	30m × 30m
Aspect	Raster file	2008	ASTER	DEM	Raster file	30m × 30m
Topographic Position Index (TPI)	Raster file	2008	ASTER	DEM	Raster file	30m × 30m
Normalized Difference Vegetation Index (NDVI)	Raster file	2008	ASTER	$\frac{(Band3 - Band2)}{(Band3 + Band2)}$	Raster file	15m × 15m
Landcover type – Bare rock, Crop field, Grass/pasture, Pine, Shrub and Forest	Raster file (Boolean file)	2007	ALOS		Raster file	10m × 10m
		1999	Majella National Park	Landcover map	Vector file	Shapefile - polygon
Soil type - Continental deposits, Marine sediments, Terrestrial sediments deposits and Limestone and marls.	Raster file (Boolean file)	1999	Majella National Park	Soil type map (soil type one)	Vector file	Shapefile - polygon

4. Research Methodology

One of the research objectives is to model the selected endemic plant taxa distribution with presence-only data so the second kind of modelling approaches was used in this research. The relevant researches are the researches of Hengl (2009) and Engler (2004).

Fig. 4-1 is the flow chat of Engler's research (2004). The objective of this research is to evaluate different methods for predicting rare species distribution and to assess the database with all records and the high spatial accuracy records. The research combined Generalized Linear Model (GLM) and ENFA. ENFA was used to predict habitat-suitability maps, and then the proportion of habitat-suitability was used as a weight to generate pseudo-absence records. The pseudo-absence records were combined with presence-only data, and this new database was used to model species distribution with GLM.

Hengl's research was an extension of Engler's idea and was devoted to computing the probability of species distribution with the Binomial GLM-based regression kriging, the density of species distribution with regression kriging and habitat-suitability index with ENFA (Fig. 4-2). In the beginning of the result, he computed the kernel density with presence-only data. Then, the ENFA was used to predict habitat-suitability maps, and the proportion of habitat-suitability was used as a weight to generate pseudo-absence records with weight random sampling. Combining the presence-only data and pseudo-absence records, this geodatabase can be used for regression modelling to predict the species distribution density.

This research extended the researches of Hengl (2009) and Engler (2004) and also used ENFA to predict habitat-suitability maps for generating pseudo-absence records with weight random sampling. Because the objective of this research is to predict distribution map, geostatistics (Indicator Kriging) was used. Fig. 4-3 shows the methodology flow chart. The three main parts are data preparing, predicting habitat-suitability maps and predicting distribution maps.

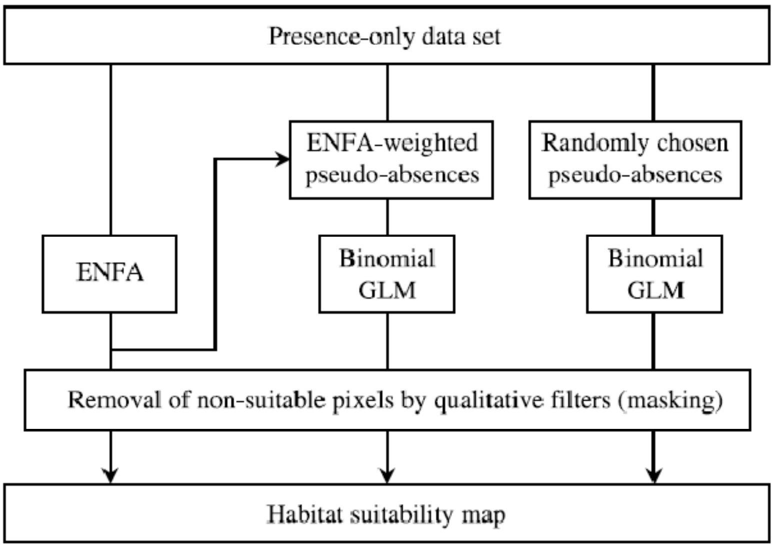

Fig. 4-1 The flow chart of Engler's research (2004)

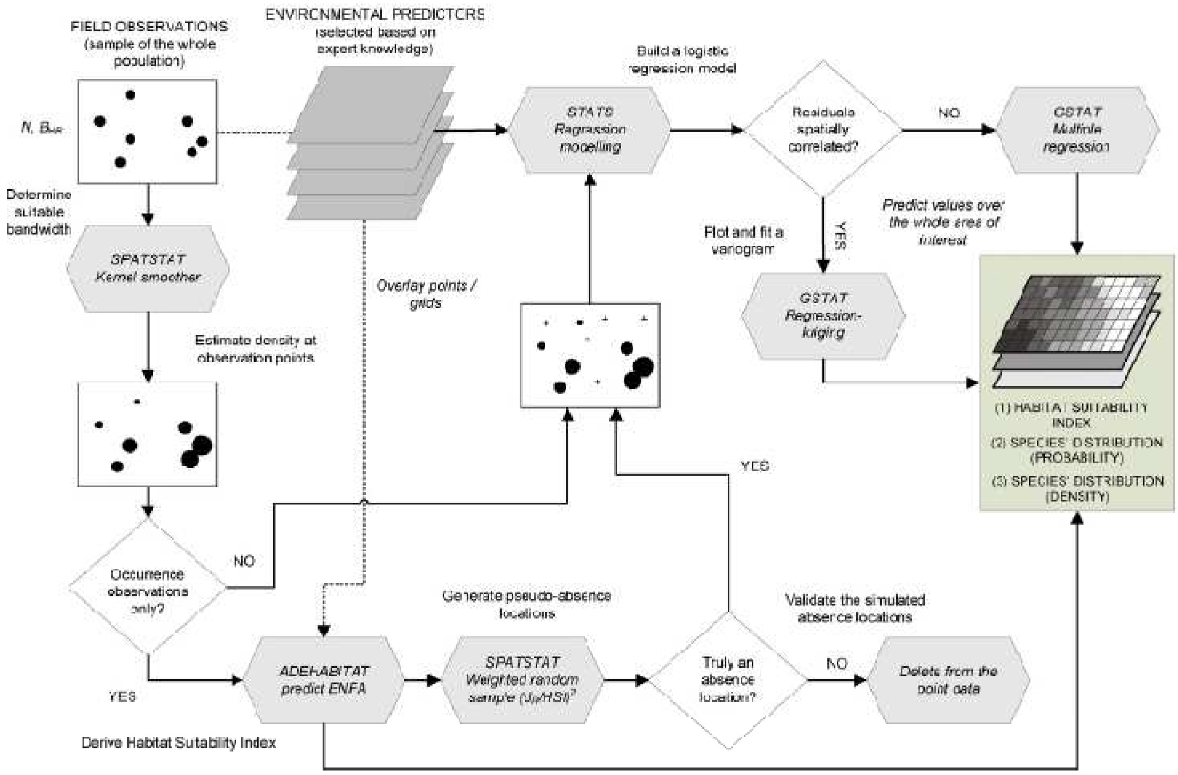

Fig. 4-2 The flow chart of Hengl's research (2009)

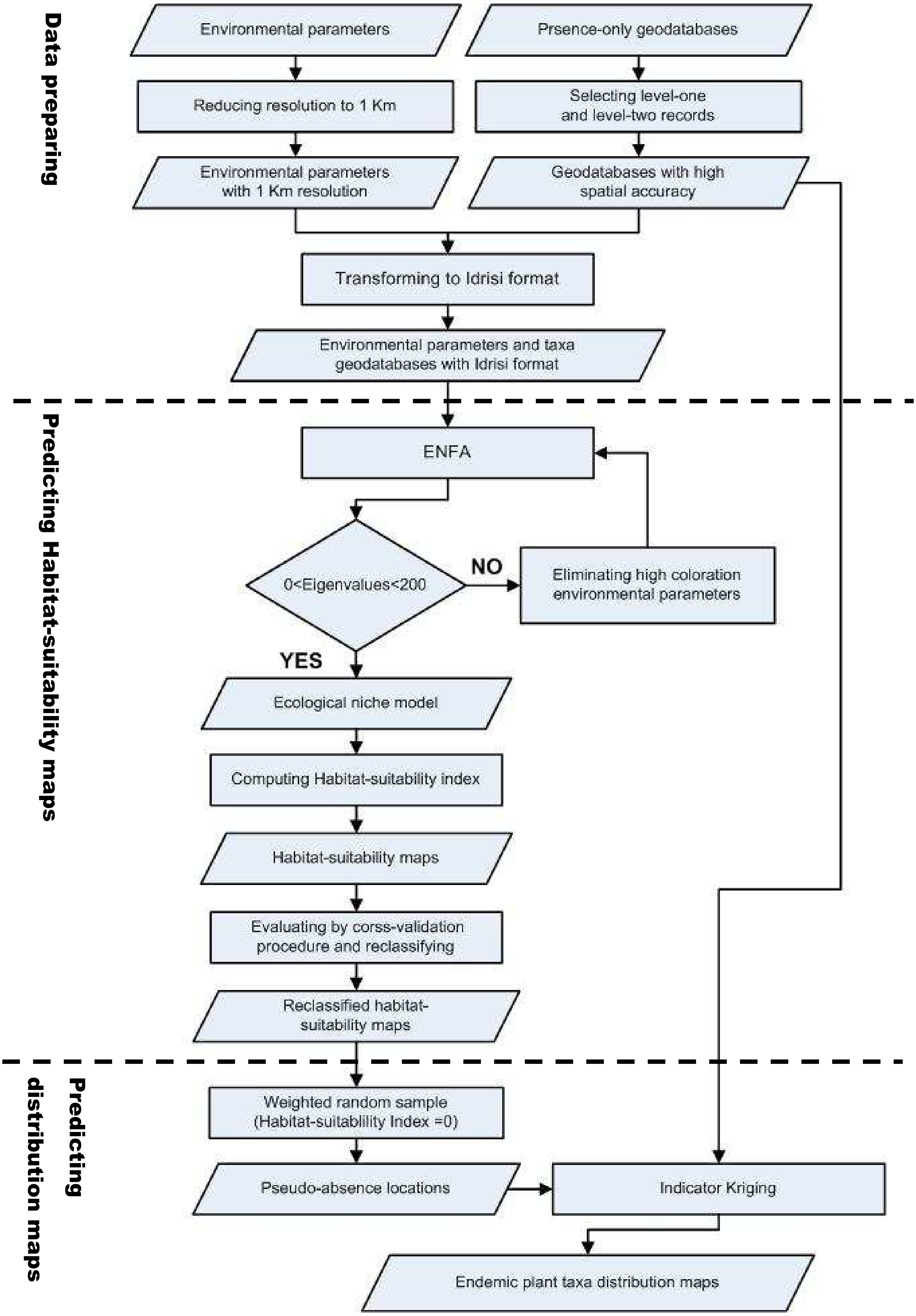

Fig. 4-3 Flow chart of the methodology

4.1. Data Preparing

The process of data preparing was taken in ArcGIS and ERDAS, and most of the procedure were mentioned in Chapter 3. In order to let data format fit BioMapper (Hirzel, et al., 2009) for further analysis the process of transforming environmental parameters layers and endemic plant taxa database to Idrisi grid format was needed. "Av2idrisi" (Schäuble & Marinoni, 2009) is a extension for converting raster format to Idrisi grid format. Environmental parameters layers can easily convert raster format to Idrisi grid format. However, plant taxa database is point so the process for converting point to raster must be taken first. Also "elevation" with 1Km resolution was chosen to import the extent settings in the general settings of environmental settings for making every environmental parameter can be overlaid. The output cell size was set in 1000m. In this research because only level-one and level-two recorders were selected, the amount of taxa which can be analyzed was limited. Considering the smoothing going of the analysis and the acceptable results, the plant taxa which had more than 10 records were selected. However, in the process of changing format each plant taxa geodatabases should change to raster image with 1km resolution, and some plant taxa became fewer records when the distance of two records was smaller than 1km.

4.2. Predicting Habitat-suitability Maps

Predicting habitat-suitability maps was taken in BioMapper (Hirzel, et al., 2009) and includes 3 processes which were explained below. The guide of predicting habitat-suitability maps are directed by the manual (Hirzel, 2005) of BioMapper.

4.2.1. ENFA

Factor analyses are used for computing ENFA in BioMapper. The factors are generated by environmental parameters. The reasons for replacing environmental parameters with factors are two. The first reason is the environmental parameters are not independent. It causes more multicollinearity and redundancy. Therefore it is necessary to transform correlated environmental parameters into uncorrelated factors. The second reason is for computing specialization factors the interactions among variables are included. Factor analyses also compute the linear combinations of environmental parameters (Hirzel, et al., 2002).

ENFA provides two kinds of information, eigenvalues and the eigenvectors. Eigenvalues describe how much variance is explained by the factors, and the factor with larger value means the factor causes more effect. Eigenvectors describe how these factors are correlated with the environmental parameters. This research used broken-stick criterion to select the significant factors, and these factors will be used for modelling Habitat-suitability maps (Hirzel, 2005). In the eigenvectors score matrix the environmental parameter with higher coefficient value (in absolute value) is the more important environmental parameters. Furthermore, the first column of the score matrix is the marginality factor, and others are specialisation factors. Marginality factor expresses the marginality of this taxa on each environmental parameters which compares to the global distribution (Hirzel, et al., 2002).

Not all environmental parameters can be used for computing factors, and the high correlation environmental parameters pairs will affect the error of computing. The criterion for making a habitat-suitability model is eigenvalues. If one or more eigenvalue is negative or too huge (> 200), one of the high correlation environmental parameters pair has to be eliminated.

4.2.2. Computing Habitat-suitability Index

Through ENFA the ecological niche model of each endemic plant taxa with factors was built, and then these models can be used for computing habitat-suitability index. There are 4 kinds of habitat-suitability algorithms in BioMapper, and they are Medians, Distance geometric mean, Distance harmonic mean and Minimum distance. Distance harmonic mean was be used in this research, because this algorithm can give better results when the sample size is very small and each observation might bring relevant information to the model (Hirzel, 2005).

Because the number of factors will affect the time of computing, this research only selected the factors contributed significant variation of habitat-suitability index. Mac Arthur's broken-stick was used to decide the number of factors included in the habitat-suitability model. A habitat-suitability map with continuous value was the output of this process.

4.2.3. Evaluating of Habitat-suitability Model and Reclassify

After ENFA and habitat-suitability computation, evaluation is the next step. An approach to evaluate the ability of habitat-suitability model is to assess how much the model predictions differ from random expectation (A. Hirzel, et al., 2006). Biomapper contributes a cross-validation procedure to evaluate the predictive accuracy of each map, and the Boyce index is used (Boyce, et al., 2002; A. H. Hirzel, et al., 2006).

In the cross-validation process deciding the number of partitions is important. The manual of BioMapper (Hirzel, 2005) suggested 10 partitions, but the number of partitions also depended on the number of taxa records (A. H. Hirzel, et al., 2006). Also the manual provided Huberty's rule (Fielding & Bell, 1997) for decision. Huberty's rule is:

$$\frac{\text{Calibration points}}{\text{Validation points}} = 1\Big/\left(1 + \sqrt{\text{the number of environmental parameters} - 1}\right)$$

This research tried to use Huberty's rule to decide. The number of partitions for 10 environmental parameters was 5, and the number for 2 environmental parameters was 3. Because the number of records for every endemic plant taxa is too few to be separate into many partitions, this research decided to use 4 partitions for evaluation.

Even though the manual (Hirzel, 2005) does not limit the number of records, a small amount records might cause unacceptable result. Because the number of records for every endemic plant taxa is less than 20, the habitat-suitability maps with continuous value would not contribute acceptable value of Boyce index (> 50%). A reclassifying process is provided for enhance the value of Boyce index. In the first result of habitat-suitability map there are 100 bins from 100% suitable habitat to 0% suitable habitat, and a model may not have delicate modelling ability in 100 bins. The aim is to reduce the number of bins by reclassifying the habitat-suitability index. In order to keep the largest number of bins, setting a threshold is necessary. This research set the threshold to 0.5 of Boyce index, and this means the final model is 50% better than random model.

Before doing reclassifying process, the curves resulting has to be adjusted. According to the variance of every partitions and the shape of the curves, the amount of points in a bin was decided. When the adjustment can contribute acceptable value of Boyce index (> 50%), this model was used for reclassifying habitat-suitability maps.

4.3. Predicting Endemic Plant Taxa Distribution Maps

Predicting distribution maps was taken in the R statistical computing environment with geostatistics (gstat package). The scripts of geostatistics were contributed from the book of Hengl (2010), and the scripts of Indicator kriging were contributed from Rossiter (2009) in the exercise 7 (Rossiter, 2009).

Before predicting distribution maps, pseudo-absence records have to be taken. Habitat-suitability maps present the degree of optimal habitat for each grid. This value of habitat-suitability index is between 0 and 100, and that means from unsuitable to optimal habitat. Thus, in the unsuitable habitat location, the value of habitat-suitability index is small, and the pseudo-absence records can be generated. The proportion of habitat-suitability was used as a weight to generate pseudo-absence records with weight random sampling process. In this process a buffer around presence-only data of 1 grid was set, and in order to extend the value of weight to whole research area, the distance-decay function was:

```
DIST=4*(sqrt(areaSpatialGrid(grids)))/5
```

The value of generate pseudo-absence records was set to be 3 times of presence-only data (observation) because these pseudo-absence records would be clip by Majella National park boundary to make sure all records was inside the boundary. After combining the clipped pseudo-absence records and presence-only data, this new database was presence/absence geodatabases. Presence/absence geodatabases can be used to predict endemic plant taxa distribution maps with Indicator kriging.
The first step was computing and modelling indicator variograms, and then Indicator kriging was second step. Because prediction with $p > 1$ is not meaningful, limiting the predicted probabilities from 0 to 1 was necessary. After plotting the probability of the indicator, the endemic plant distribution map was predicted.

5. Results

5.1. Endemic Plant Taxa Database

There are 146 endemic plant taxa which are present in the Majella National Park, and the list is in Table A in Appendices. In the "Flora d'Italia" (Pignatti, 1982) the rare levels of plant taxa are shown, and the levels are classified into three level, i.e. rare, very rare and normal (Table B in Appendices). Table 5-1 is the integration from Table B. This table shows more than half of these endemic plant taxa identified in the book can be distribution above the timberline (the altitude of timberline is almost 1800m)(67.2%), and also most of the endemic plant taxa is rare or very rare (70.8%).

Table 5-1 The rare level of endemic plant taxa

The altitude of the highest distribution (m)	Rare level of endemic plant taxa						Sum	
	Rare		Very rare		Normal			
	N	%	N	%	N	%	N	%
1≤altitude<1,800	24	33.3	3	18.8	16	37.2	43	32.8
1,800≤altitude<2,500	36	50.0	9	56.3	19	44.2	64	48.9
2,500≤altitude	12	16.7	4	25.0	8	18.6	24	18.3
Sum	72	100.0	16	100.0	43	100.0	131	100.0

Fig. 5-1 shows the flowering period of endemic plant taxa in Majella National Park. This information was also integration from Table B. This figure expressed the flowering period massed from May to August, and the average length is 2.8 months with standard divination of 1.3. Most of the taxa has 2 months (61) and 3 months (43) flowering period (Fig. 5-2).

These integrations stated that endemic plant taxa in Majella National Park have high probability above the timberline and short flowering period. Distribution in the high altitude location decreases the accessibility of field work. Some plants taxa tend to grow over 2,500m, and these taxa are covered by snow whole winter or more than winter period. This limits the growing period and flowering period, and this also cause the short flowering period. However, flower is one of the important elements for discriminating plant taxa. The short flowering period increases the limitation of field work.

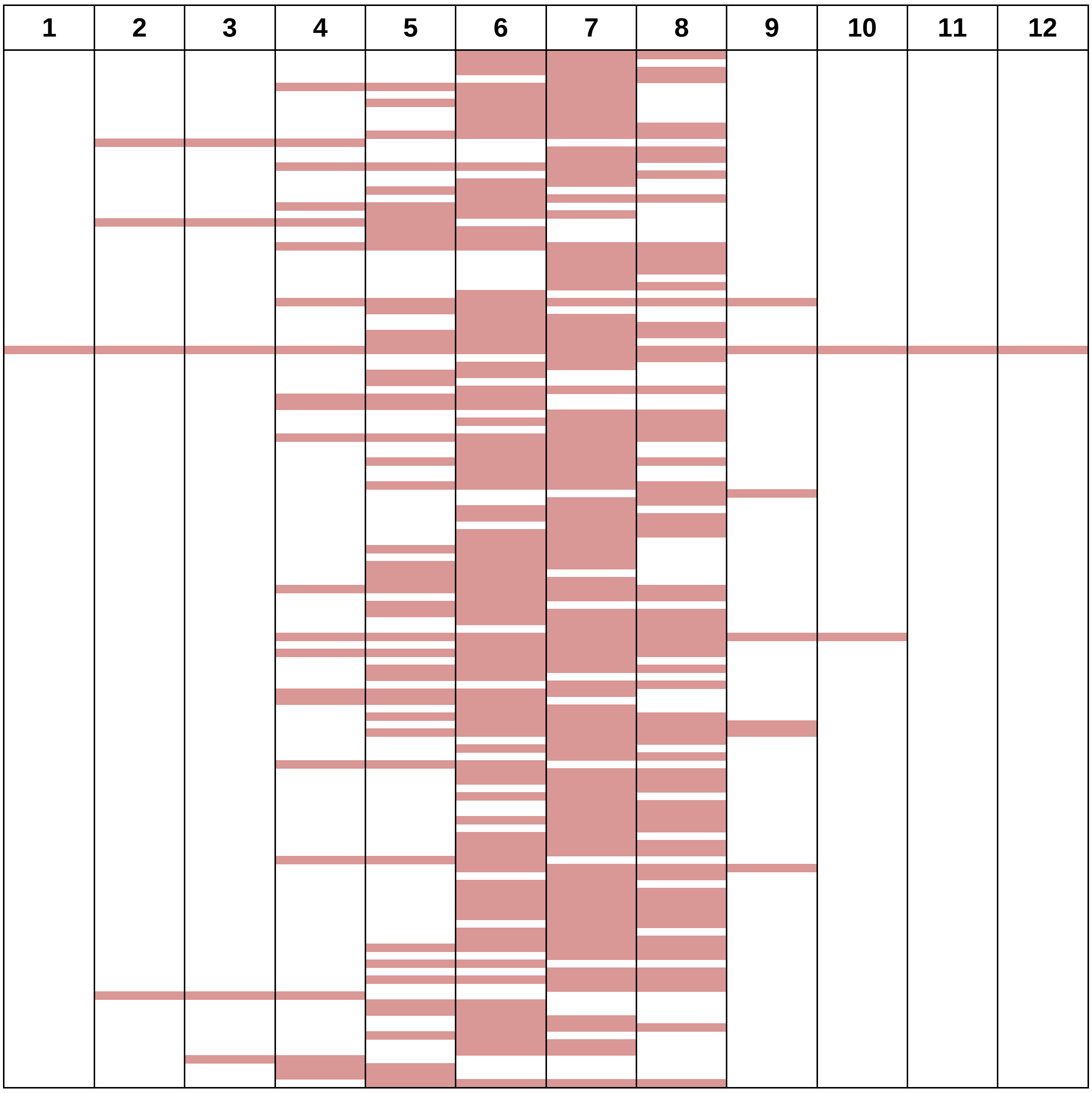

Fig. 5-1 The flowering period of endemic plant taxa in Majella National Park

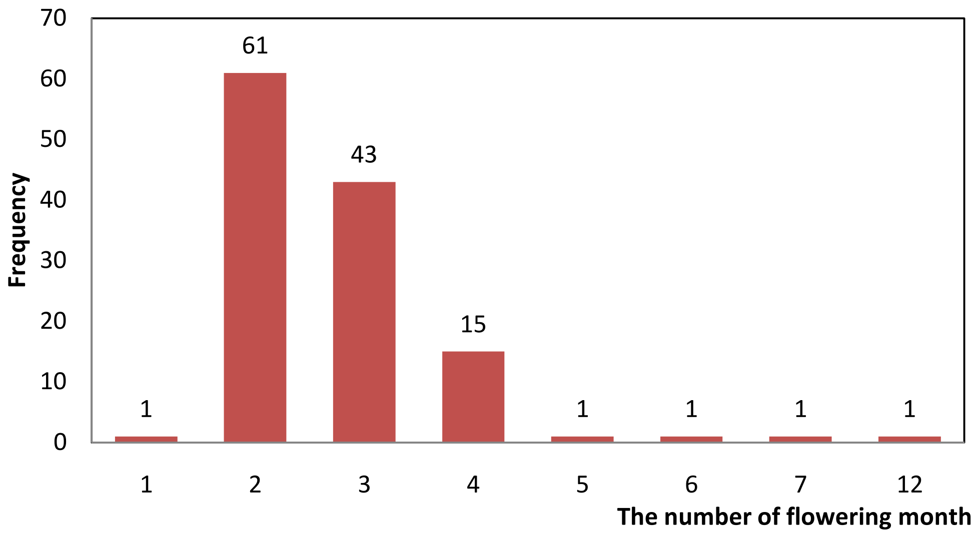

Fig. 5-2 The frequency of flowering month of endemic plant taxa

Table D in appendices shows the endemic plant taxa geodatabase used in this research, and Table 5-2 shows the sources of geodatabase. This presence-only database contained 1,560 records, and bibliographic reference contributed more than half records. Most of the records are level-three spatial accuracy.

Table 5-2 The number of individual endemic plant taxa in the geodatabases

Sources of geodatabase	Spatial accuracy				Sum	
	Level-one	Level-two	Level-three	Level-four	N	%
Bibliographic	0	149	687	129	965	61.9
Herbarium	118	59	171	15	363	23.3
Index Seminum	0	106	50	0	156	10.0
Romeo Di Pietro	76	0	0	0	76	4.9
Sum	194	314	908	144	1560	100.0

The records with level- one spatial accuracy are preferred for analysis, but the amount of these records is low (Table 5-3). Only one plant taxa has 10 records, and others are fewer than 10. Therefore the records with level- two spatial accuracy have to be added.

5.2. ENFA and Habitat-suitability Maps

Because only level-one and level-two spatial accuracy records were selected in this research, the number of plant taxa with more than 10 presence-only records is only 14, and the list is shown on Table 5-3. These 14 plant taxa are included in 5 life forms; Ch pulv, Ch suffr, H caesp, H ros and H scap. The translation (Guarino, et al., 2008) of these 5 kinds of life forms is in Table 5-4. Because of the limitation of time, this research only picked 2 taxa with most records in every life form for analysis. Besides, *Adonis distorta* was also selected for analysis, because this taxa would be used for further discussion.

Table 5-3 The list of plant taxa with more than 10 presence-only records

Selected	*Check-list code	**Taxa	Life-form	Number of individual presence-only records		
				Level-one	Level-two	Sum
✓	6078	*Centaurea tenoreana*	H scap	6	10	16
✓	836	*Silene notarisii*	H scap	4	11	15
	5970	*Centaurea rupestris* subsp. *ceratophylla*	H scap	7	7	14
✓	1075	*Adonis distorta*	H scap	7	6	13
	3659	*Laserpitium siler*	H scap	4	6	10
	4162	*Galium magellense*	H scap	5	5	10
	5265	*Lomelosia crenata* subsp. *pseudisetensis*	H scap	4	6	10
✓	1851	*Saxifraga porophylla*	Ch pulv	3	7	10
✓	674	*Cerastium tomentosum*	Ch suffr	3	11	14
✓	682	*Cerastium thomasii*	Ch suffr	9	3	12
✓	5633	*Achillea barrelieri* subsp. *barrelieri*	H caesp	10	8	18
✓	7257	*Festuca violacea* subsp. *Italica*	H caesp	7	6	13
✓	3844	*Armeria majellensis* subsp. *majellensis*	H ros	8	3	11
✓	4998	*Pedicularis elegans*	H ros	9	2	11

* : "Checklist code" is adopted from "An Annotated Checklist of the Italian Vascular Flora" (Giovanna, et al., 2005).

** :"Taxa" is plant nomenclature which is adopted from "An Annotated Checklist of the Italian Vascular Flora" (Giovanna, et al., 2005).

Table 5-4 The translation of life form

Abbreviation	Life form in Italian	Life form in English
Ch pulv	camefite pulvinate	chamaephytes pulvinate
Ch suffr	camefite suffruticose	chamaephytes suffruticose
H caesp	emicriptofite cespitose	hemicryptophytes scapose
H ros	emicriptofite rosulate	hemicryptophytes rosulate
H scap	emicriptofite scapose	chamaephytes scapose

5.2.1. *Centaurea tenoreana*

Centaurea tenoreana is perennial herbaceous and is very rare endemic plant taxa. Its life form is H scap (chamaephytes scapose). It is present from 1,700m to 2,000m. The Living plant is about 40cm to 70cm, and the flowering period is from July to August (Pignatti, 1982).

The first step in the process of predicting habitat-suitability Maps is ENFA. All 10 environmental parameters were added for building the ecological niche model. From the analysis result there is no too high correlation pair of environmental parameters so all 10 environmental parameters were remained. The result of ENFA is eigenvalues and eigenvectors score matrix (Table 5-5). These 10 environmental parameters were transformed into 10 factors. Through the broken-stick criterion only 2 factors can significantly affect the ecological niche model, so only 2 factors, marginality factor and specialisation factor 1, were involved in the model. These 2 factors accounted for 89% of total information. The marginality factor explained 100% of marginality, and this factor also explained 50.9% specialisation. The high value of explained proportion for specialisation in marginality factor means this taxa tends to grow in this kind of habitat very restrictedly. Another factor can explain 26.9% of specialisation. Marginality factor express the fact that the taxa differs from the global. The highest coefficient value of slope (0.538) means *Centaurea tenoreana* tends to grow in the steep place and also in the high elevation (0.346). Nevertheless, the negative value with high absolute vale of incoming solar radiation expressed this taxa does not need plenty solar energy.

The specialisation factor 1 express *Centaurea tenoreana* tends to sensitively shift away from their optimal habitat on low solar energy place in summer. From "Flora d'Italia" (Pignatti, 1982) the flowering period is from July to August, so it can be inferred that *Centaurea tenoreana* in the flowering period needs some shelter from solar energy.

This ecological niche model with 2 factors was used for computing habitat-suitability index. The predicted unclassified habitat-suitability map of *Centaurea tenoreana* is shown on Fig. 5-3. Through the evaluation process with cross-validation the value of Boyce indicator is 0.24 ± 0.05, and this expressed this model is just a bit better than random model. The reason of low accuracy is because the poor geodatabase, and Hirzel (2005) suggested the geodatabase with more than 30 records can get better result in BioMapper. According to the low accuracy result, the reclassified process is needed.

Table 5-5 The eigenvalues and eigenvectors score matrix of *Centaurea tenoreana*

Factor	Marginality Factor	Specialisation Factor 1
Eigenvalue	27.196	14.392
The ratio of explained specialisation (%)	50.9	26.9
The coefficient value of each environmental parameter		
Aspect	-0.069	-0.411
Elevation	0.346	0.236
NDVI	-0.069	-0.351
Slope	0.538	-0.059
Soil type- Continental deposits	-0.216	0.114
Soil type- Limestone and marls	0.301	-0.493
Incoming spring solar radiation	-0.343	0.340
Incoming summer solar radiation	-0.388	-0.522
Incoming annual solar radiation	-0.352	0.064
TPI	-0.227	-0.034

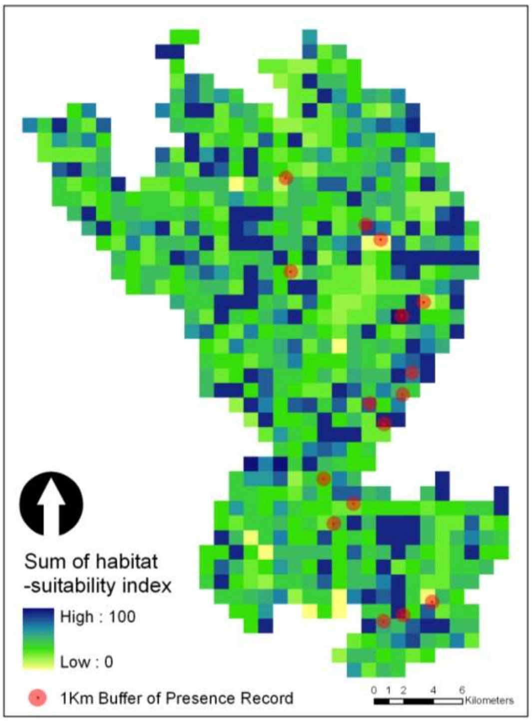

Fig. 5-3 The unclassified habitat-suitability map of *Centaurea tenoreana* in Majella National Park

In order to get a reliable model the aim of reclassifying is to reduce the number of bins and also to keep the largest number of bins. In *Centaurea tenoreana* the habitat-suitability index was classified into 3 bins, and the Boyce index is 0.622 ± 0.17. The curves resulting of cross-validation process (Fig. 5-4) give the response of classifying. The 3 lines in different colours mean 3 different partitions. The variance of 3 partitions in one bin expresses the predictive power, and the smaller variance the better. For this curves resulting, the prediction in core habitat has smallest variance, and it means this model can predict the core habitat better. This acceptable model was used to predict habitat-suitability map, and the result was shown in Fig. 5-5. In this predicted map the core habitats separate in the whole Majella National Park, but they are not in the high altitude part of Majella massif which is a bare area.

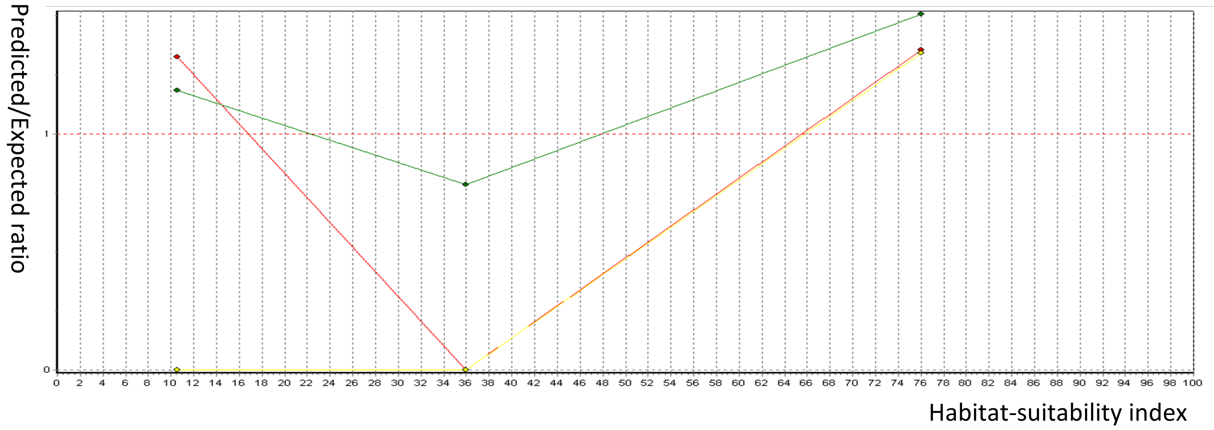

Fig. 5-4 The curves resulting of cross-validation process of *Centaurea tenoreana*

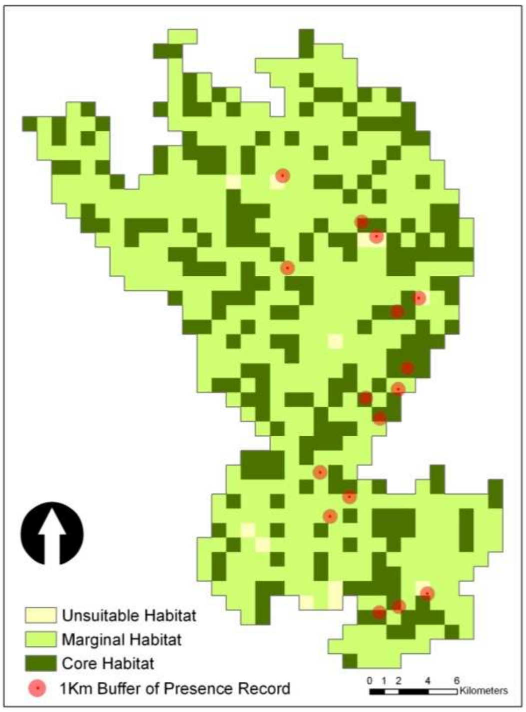

Fig. 5-5 The habitat-suitability map of *Centaurea tenoreana* in Majella National Park

5.2.2. *Silene notarisii*

The eigenvalues and eigenvectors score matrix of *Silene notarisii* (Table 5-6) shows there are 9 environmental parameters selected in building ecological niche model. According to broken-stick criterion, there are only 2 factors which can significant affect the computing of suitability. The marginality factor accounts 100% of marginality and only 5% of specialisation. Therefore the specialisation factor 1 (88.3%) accounts most of the specialisation. This lower eigenvalue for marginality factor means that the niche breadth is not related to the same environmental parameters, and the combination of environmental parameters that explained the species marginality does not explain its specialization appropriately.

In the analysis of the marginality factor slope (0.580) is the most explanatory environmental parameter, and this expresses *Silene notarisii* likes to grow in steep slope area. Incoming annual solar radiation (-0.334) and incoming summer solar radiation (-0.389) are also have high contribution, and they are negative value. This means *Silene notarisii* does not like too much solar energy, and the negative value of NDVI (-0.161) can support this argument. The specialisation factor 1 can explain the restrict environment parameters. From the score matrix soil type- Limestone and marls and aspect get higher coefficient value so these two environmental parameters cause variation of the distribution.

Table 5-6 The eigenvalues and eigenvectors score matrix of *Silene notarisii*

Factor	Marginality Factor	Specialisation Factor 1
Eigenvalue	14.308	252.697
The ratio of explained specialisation (%)	5.0	88.3
The coefficient value of each environmental parameter		
Aspect	-0.352	-0.538
Elevation	-0.022	-0.178
NDVI	-0.161	-0.006
Slope	0.580	0.314
Soil type- Continental deposits	-0.093	-0.285
Soil type- Limestone and marls	0.471	-0.581
Incoming summer solar radiation	-0.389	0.394
Incoming annual solar radiation	-0.334	-0.046
TPI	-0.140	-0.065

After the reclassified and evaluation, a habitat-suitability map for *Silene notarisii* is presented in Fig. 5-6. According to the cross-validation process the most optimal model of this taxa included 4 bins. The value of Boyce indicator is 0.8 ± 0.2828 and means this model is better than a random model. The map shows all of the present records are in the high marginal habitat.

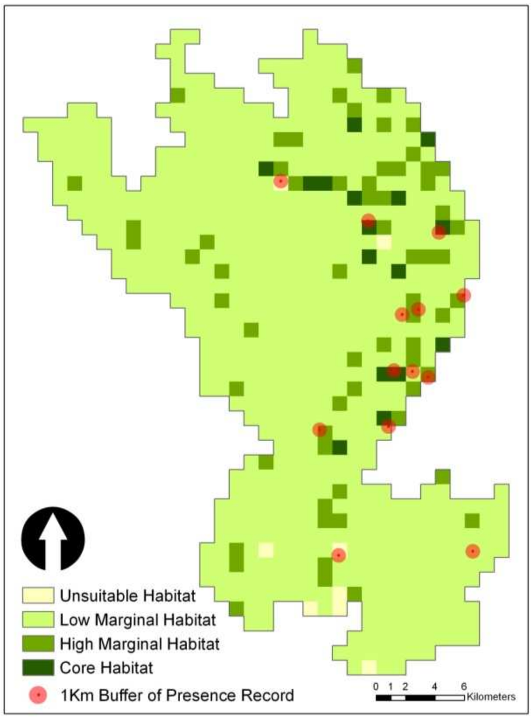

Fig. 5-6 The habitat-suitability map of *Silene notarisii* in Majella National Park

5.2.3. *Adonis distorta*

After eliminating high coloration environmental parameters, there are only 4 parameters in the ecological niche model. These 4 parameters transformed to 4 uncorrelated factors, and these 4 factors were all selected by the broken-stick criterion. Thus, these 4 factors can explain 100% information. The first factor is always the marginality factor, and in the taxa the marginality factor also can explained 62.1% specialisation. The others are specialisation factor 1,2 and 3. The eigenvalues and eigenvectors score matrix of *Adonis distorta* was shown in Table 5-7.

Though the coefficient value in marginality factor the habitat of *Adonis distorta* can be realized. The absolute value of elevation (0.692) and NDVI (-0.652) are the highest. This expresses this taxa tends to grow in high altitude location, and the negative value of NDVI means this taxa tends to grow in the bare or open vegetation area. The specialisation factors states this taxa is sensitive to soil type- Limestone and marls (positive effect), aspect (positive effect).

Table 5-7 The eigenvalues and eigenvectors score matrix of *Adonis distorta*

Factor	Marginality Factor	Specialisation Factor 1	Specialisation Factor 2	Specialisation Factor 3
Eigenvalue	39.412	14.399	7.997	1.68
The ratio of explained specialisation (%)	62.1	22.7	12.6	2.6
The coefficient value of each environmental parameter				
Aspect	-0.23	0.115	0.393	0.81
Elevation	0.692	-0.678	0.345	0.201
NDVI	-0.652	-0.668	0.457	-0.232
Soil type- Limestone and marls	0.208	0.285	0.719	-0.499

According to the result of cross-validation, the records should be classified into 4 classes in order to remain largest number of bins with more than 0.5 of Boyce index. The habitat-suitability map of *Adonis distorta* was shown in Fig. 5-7, and the Boyce index is 0.76 $\pm$ 0.14. In the map the core habitat and high marginal habitat are all in the high altitude parts of Majella massif, and the present records are also in the high altitude parts of Majella massif. However, there is a low marginal habitat in Mount Morrone in the north-west part of Majella National Park, but there is no present record near that location.

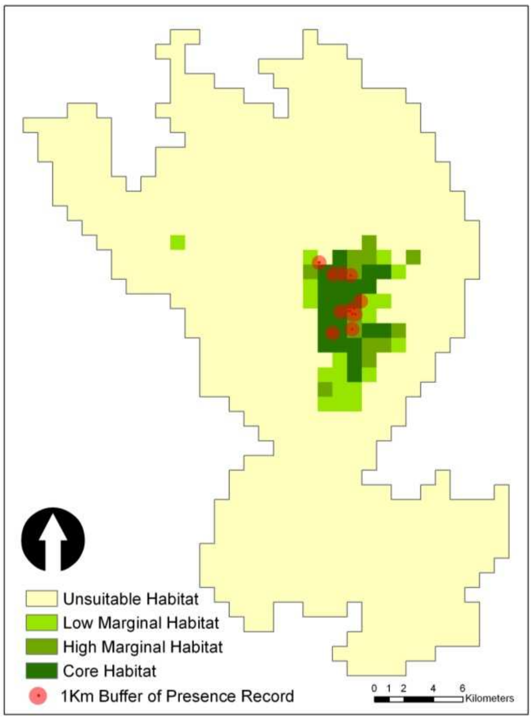

Fig. 5-7 The habitat-suitability map of *Adonis distorta* in Majella National Park

5.2.4. *Saxifraga porophylla*

The eigenvalues and eigenvectors score matrix is shown in Table 5-8. The ENFA of *Saxifraga porophylla* included 7 environmental parameters, after the high correlated environmental parameters are eliminated. These parameters transformed into 7 uncorrelated factors. Through the broken-stick criterion, there are only 2 factors selected which can effect the ENFA significantly. These 2 factors account for 98% of total sum of eigenvalue.

The marginality factor accounts for 54.2% of total sum of eigenvalue, and elevation (0.655) got the highest coefficient value of this matrix. This means elevation affects the distribution of *Saxifraga porophylla* most, and the positive value means this plant tends to grow in high elevation place. Soil type- Continental deposits (0.439) and Limestone and marls (0.464) also contribute high effect, so this taxa is easier found in both kind of soil layers. Slope (-0.419) gives negative effect so this plant tends to grow in gentle slope (Table 5-8).

The specialisation factor 1 express *Saxifraga porophylla* tends to sensitively shift away from their optimal habitat on aspect (0.559), Soil type- Continental deposits (0.573) and TPI (0.559)(Table 5-8).

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Table 5-8 The eigenvalues and eigenvectors score matrix of *Saxifraga porophylla*

Factor	Marginality Factor	Specialisation Factor 1
Eigenvalue	80.541	62.586
The ratio of explained specialisation (%)	54.2	42.1
The coefficient value of each environmental parameter		
Aspect	-0.120	0.559
Elevation	0.655	0.154
Slope	-0.419	0.312
Soil type- Continental deposits	0.439	0.573
Soil type- Limestone and marls	0.406	-0.451
Incoming summer solar radiation	0.155	0.187
TPI	-0.120	0.559

After the reclassified and evaluation, a habitat-suitability map for *Saxifraga porophylla* is presented in Fig. 5-8. According to the cross-validation process the most optimal model of this taxa included 3 bins. The value of Boyce indicator is 0.866 and means this model is better than a random model. The map shows all of the present records are in the core habitat.

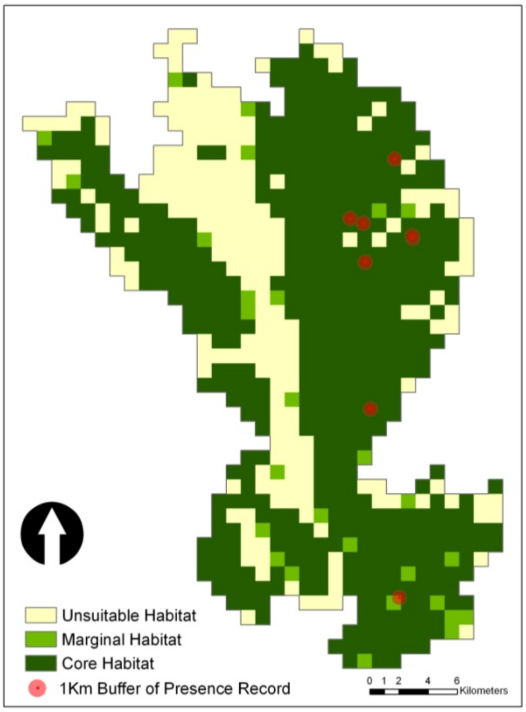


Fig. 5-8 The habitat-suitability map for *Saxifraga porophylla* in Majella National Park

5.2.5. *Cerastium tomentosum*

In the ENFA computing of *Cerastium tomentosum* there are 9 environmental parameters selected and 4 factors selected (Table 5-9). These 4 factors can explain 91% of total sum of eigenvalue. The marginality factor accounts only 17.8% for specialisation. The specialisation factor 1, 2 and 3 can explain 27.2%, 17.1% and 15.7% of specialisation.

The marginality factor expresses how much each environmental parameter contributes in ENFA. The highest coefficient value of the marginality factor is NDVI (-0.589), and this expresses this taxa also tends to grow in open area. However, the coefficient value of incoming annual solar radiation (0.374), incoming summer solar radiation (0.285) and incoming spring solar radiation (0.424) are also high, and they also give positive effect. This means *Cerastium tomentosum* needs high solar energy, and this supports high negative coefficient value of NDVI.

The specialisation factor 1 (27.2%) is the most important factor to account specialisation. The coefficient value of incoming solar radiation of spring is extremely high, and it is-0.746. That means *Cerastium tomentosum* is sensitive to solar energy in spring. Besides of incoming spring solar radiation, incoming summer solar radiation (0.576) also causes variation of the distribution (Table 5-9).

Table 5-9 The eigenvalues and eigenvectors score matrix of *Cerastium tomentosum*

Factor	Marginality Factor	Specialisation Factor 1	Specialisation Factor 2	Specialisation Factor 3
Eigenvalue	3.983	6.095	3.833	3.521
The ratio of explained specialisation (%)	17.8	27.2	17.1	15.7
The coefficient value of each environmental parameter				
Aspect	0.047	0.169	0.072	0.169
Elevation	0.277	0.105	-0.251	0.087
NDVI	-0.589	-0.062	0.065	-0.077
Slope	0.261	0.243	0.306	-0.322
Soil type- Limestone and marls	0.115	-0.067	-0.047	-0.086
Incoming spring solar radiation	0.424	-0.746	-0.479	0.452
Incoming summer solar radiation	0.285	0.576	0.770	-0.784
Incoming annual solar radiation	0.374	0.066	-0.033	0.164
TPI	-0.304	0.006	-0.086	0.043

According to the curves resulting of cross-validation process the value of habitat-suitability probability was classified into 4 bins. The value of Boyce indicator is 0.783 ± 0.1429. Fig. 5-9 is the habitat-suitability map for *Cerastium tomentosum* in Majella National Park. The presence-only records of

Cerastium tomentosum are overlaid on the map. Most of the points with 1 Km buffer are in the high marginal habitat and core habitat.

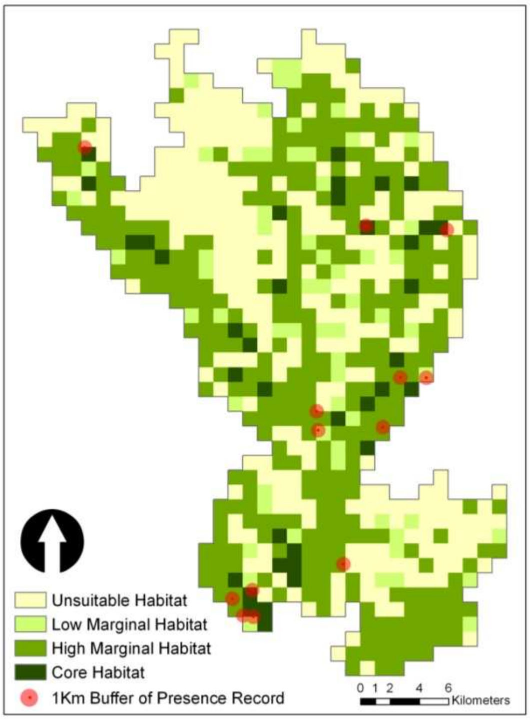


Fig. 5-9 The habitat-suitability map for *Cerastium tomentosum* in Majella National Park

5.2.6. *Cerastium thomasii*

The ENFA of *Cerastium thomasii* only contains 2 environmental parameters, and these two parameters transforms into 2 factors. These 2 factors can explain 100% of this habitat model. Table 5-10 express the eigenvalues and eigenvectors score matrix. The Marginality factor accounts 88.7% of total sum of eigenvalue, and this high proportion express *Cerastium thomasii* displays a very restricted range on this condition, comparing to whole study area. Elevation (0.958) is the most explanatory environmental parameter, and the higher, the plant tends to grow.

Table 5-10 The eigenvalues and eigenvectors score matrix of *Cerastium thomasii*

Factor	Marginality Factor	Specialisation Factor 1
Eigenvalue	46.101	5.901
The ratio of explained specialisation (%)	88.7	11.3
The coefficient value of each environmental parameter		
Elevation	0.958	-0.286
Soil type- Limestone and marls	0.286	0.958

The value of habitat-suitability probability was classified into 3 bins in this model, and the Boyce indicator is 0.774±0.1725. Fig. 5-10 is the habitat-suitability map for *Cerastium thomasii*. The core habitat aggregates on the top of Majella massif where a highest place of the study area is.

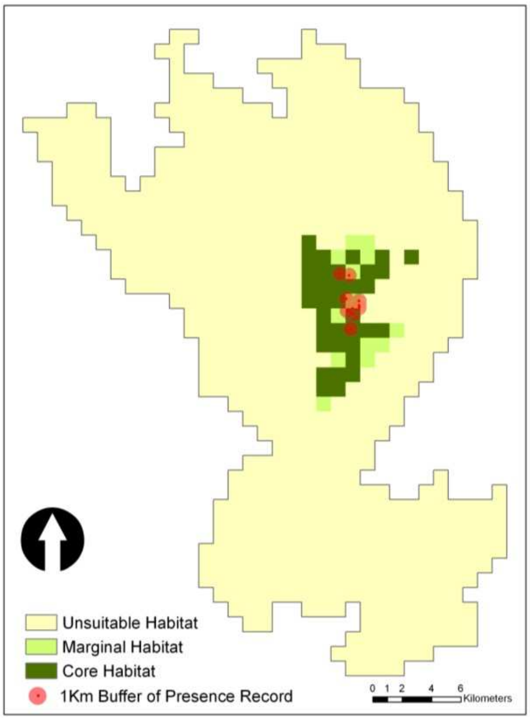


Fig. 5-10 The habitat-suitability map for *Cerastium thomasii* in Majella National Park

5.2.7. ***Achillea barrelieri*** **subsp.** ***barrelieri***

The score matrix result of *Achillea barrelieri* subsp. *barrelieri* is shown in Table 5-11. There are 7 environmental parameter selected for transforming to factors. However, there are only 2 factors can significantly affect ENFA. These two factors account 99% of total sum of eigenvalue. In marginality factor it is shown that elevation (0.687) and slope (-0.620) are the most explanatory parameters, and this can be explained that *Achillea barrelieri* subsp. *barrelieri* tends to grow in high elevation and gentle slope place. Specialisation factor 1 expresses this taxa is also sensitive to the soil type-Limestone and marls change.

Fig. 5-11 is the habitat-suitability map for *Achillea barrelieri* subsp. *barrelieri*. The Boyce indicator of this model is 0.686±0.3134, and the value of habitat-suitability probability is classified in 4 bins. Most of the core habitat is in the high elevation part.

Table 5-11 The eigenvalues and eigenvectors score matrix of *Achillea barrelieri* subsp. *barrelieri*

Factor	Marginality Factor	Specialisation Factor 1
Eigenvalue	246.939	106.246
The ratio of explained specialisation (%)	68.6	29.5
The coefficient value of each environmental parameter		
Aspect	-0.130	-0.031
Elevation	0.687	0.557
Slope	-0.620	0.312
Soil type-Continental deposits	-0.038	-0.418
Soil type- Limestone and marls	0.315	-0.645
Incoming summer solar radiation	0.159	-0.036
TPI	-0.130	-0.031

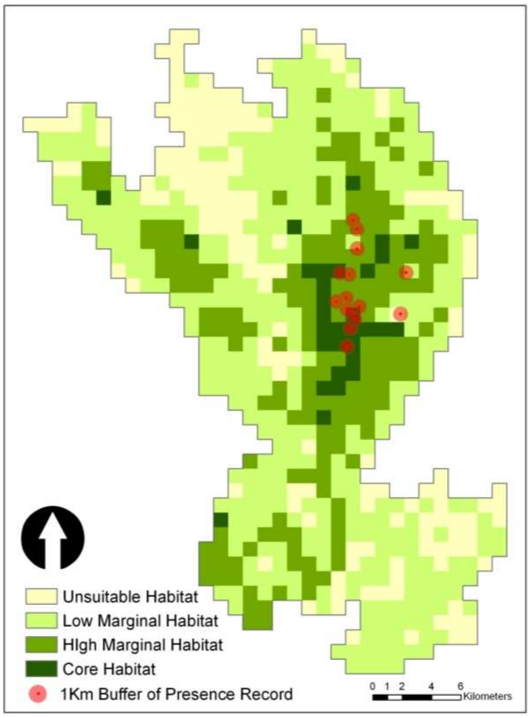


Fig. 5-11 The habitat-suitability map for *Achillea barrelieri* subsp. *barrelieri* in Majella National Park

5.2.8. ***Festuca violacea* subsp. *italica***

The eigenvalues and the eigenvectors score matrices of *Festuca violacea* subsp. *italica* are shown in Table 5-12. The ENFA of *Festuca violacea* subsp. *italica* included 9 environmental parameters, after the high correlated environmental parameters are jettisoned. Through the broken-stick criterion, there are four factors selected, and these four factors account for 98% of total sum of eigenvalue. The marginality factor accounts 64.9% for specialisation. The marginality factor expresses elevation (0.632) is the most explanatory environmental parameter, and this taxa tends to grow in high elevation places. NDVI (-0.599) contributes a high negative effect, and the negative value expresses this taxa grows in the open area. Incoming summer solar radiation (0.303) also gives high effect, and this value expresses this plant tends to grow in the place with high solar energy in summer. The specialisation factor 1 expresses *Festuca violacea* subsp. *italica* is the most sensitive to Soil type- Limestone and marls (0.711) and Soil type-Continental deposits (0.526) so the distribution range of *Festuca violacea* subsp. *italica* is more restricted by these two soil types. The specialisation factor 2 expresses this taxa is also restricted by NDVI (-0.704) and elevation (-0.589).

Table 5-12 The eigenvalues and eigenvectors score matrix of *Festuca violacea* subsp. *italica*

Factor	Marginality Factor	Specialisation Factor 1	Specialisation Factor 2	Specialisation Factor 3
Eigenvalue	94.266	23.451	13.226	8.45
The ratio of explained specialisation (%)	64.9	16.2	9.1	5.8
The coefficient value of each environmental parameter				
Aspect	-0.123	0.01	0.232	-0.24
Elevation	0.632	-0.22	-0.589	-0.287
NDVI	-0.599	0.089	-0.704	-0.175
Slope	0.063	0.011	-0.112	0.227
Soil type- Continental deposits	-0.002	0.526	-0.301	0.111
Soil type- Limestone and marls	0.258	0.711	-0.029	-0.181
Incoming summer solar radiation	0.303	0.264	-0.018	0.669
Incoming annual solar radiation	0.249	-0.294	-0.01	-0.519
TPI	0.049	0.073	0.016	0.122

The value of habitat-suitability probability was classified into 3 bins. The value of Boyce indicator is 0.866 and means this habitat-suitability model is better than a random model. The Habitat-suitability map for *Festuca violacea* subsp. *italica* is shown in Fig. 5-12. The high habitat-suitability values part shows the high quality habitat of *Festuca violacea* subsp. *italica*. Most of the core habitat is in high place.

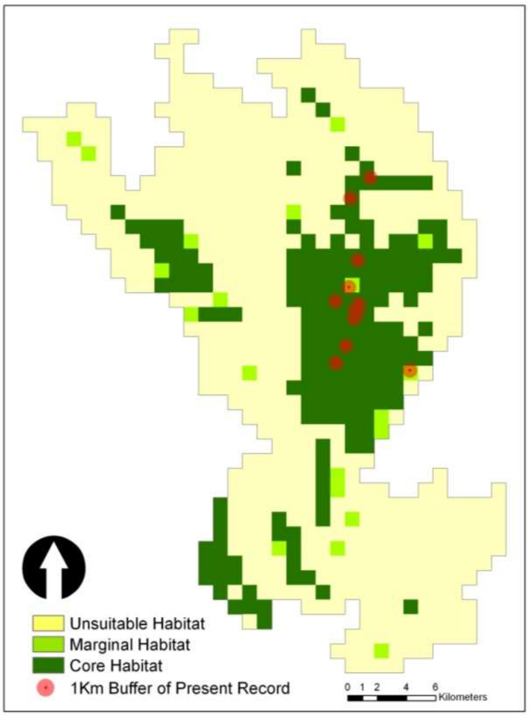


Fig. 5-12 The habitat-suitability map for *Festuca violacea* subsp. *italica* in Majella National Park

5.2.9. *Armeria majellensis* subsp. *majellensis*

Table 5-13 shows The eigenvalues and eigenvectors score matrix of *Armeria majellensis* subsp. *majellensis.* There are 5 environmental parameters selected, and only 4 factors can contribute significant effect of ENFA. These 4 factors account 100% of total sum of eigenvalue. In the marginality factor, elevation (0.674) and NDVI (-0.653) are the most explanatory parameters. This also can be explained that *Armeria majellensis* subsp. *majellensis* tends to grow in a high altitude and open area. The specialisation factors show that this taxa tends to shift away from its optimal habitat on NDVI and elevation.

Table 5-13 The eigenvalues and eigenvectors score matrix of *Armeria majellensis* subsp. *majellensis*

Factor	Marginality Factor	Specialisation Factor 1	Specialisation Factor 2	Specialisation Factor 3
Eigenvalue	48.322	28.341	13.029	2.804
The ratio of explained specialisation (%)	52	30.5	14	3
The coefficient value of each environmental parameter				
Aspect	-0.234	0.169	-0.234	0.169
Elevation	0.674	-0.654	0.674	-0.654
NDVI	-0.653	-0.734	-0.653	-0.734
Soil type- Limestone and marls	0.241	0.023	0.241	0.023
TPI	-0.076	0.067	-0.076	0.067

In Fig. 5-13 it is shown the habitat-suitability map for *Armeria majellensis* subsp. *majellensis.* In this model the Boyce indicator is 0.622±0.2161, and the value of habitat-suitability probability is classified into 4 bins. The 1 Km buffer of present data are in the marginal habitat and core habitat. The core habitat aggregates in high altitude part.

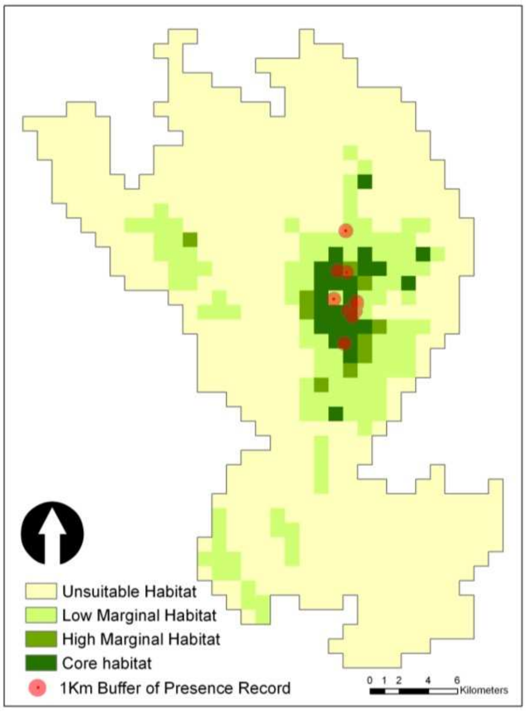


Fig. 5-13 The habitat-suitability map for *Armeria majellensis* subsp. *majellensis* in Majella National Park

5.2.10.*Pedicularis elegans*

After eliminating high coloration environmental parameters, there are only 6 parameters in the ecological niche model. These 6 parameters transformed to 6 uncorrelated factors, and only 3 factors were all selected by the broken-stick criterion. Thus, these 3 factors can explain 94% information. Table 5-3 shows The eigenvalues and eigenvectors score matrix of *Pedicularis elegans.* The specialisation factor 1 (54.1%) accounted the biggest part of specialisation, and marginality factor only accounted 10.4% (Table 5-14).

In the marginality factor the absolute value of elevation (0.654) and NDVI (-0.657) are the highest. This expresses this taxa tends to grow in high altitude location, and the negative value of NDVI means this taxa tends to grow in the bare or open vegetation area. The specialisation factors states this taxa is sensitive to soil type- Limestone and marls (positive effect)(Table 5-14).

Table 5-14 The eigenvalues and eigenvectors score matrix of *Pedicularis elegans*

Factor	Marginality Factor	Specialisation Factor 1	Specialisation Factor 2
Eigenvalue	5.712	29.831	12.841
The ratio of explained specialisation (%)	10.4	54.1	23.3
The coefficient value of each environmental parameter			
Aspect	-0.275	0.121	0.085
Elevation	0.654	0.665	-0.346
NDVI	-0.657	0.687	-0.038
Soil type- Continental deposits	-0.008	-0.184	-0.237
Soil type- Limestone and marls	0.246	0.173	0.903
TPI	-0.06	-0.086	-0.017

The result of habitat-suitability map with 100 bins can not achieve the threshold of 0.5 Boyce index, so the reclassified process was used, too. However, even though the bins were reduced to 2, the Boyce index still can not larger than 0. It means this model can not be better than random distribution with these factors.

5.2.11.Environmental parameters for predicting suitable habitat

Though ENFA the most explanatory environmental parameter of each taxa can be known. Table 5-15 was integration from marginality factors of every endemic plant taxa and showed their most explanatory environmental parameters. Elevation and NDVI are the most frequent explanatory environmental parameters, and almost all of the endemic plant tends to grow in high elevations (positive value in elevation) and open area (negative value in NDVI).

Table 5-15 The two most explanatory environmental parameters of ENFA

Life form	Name of plant taxa	The two most explanatory environmental parameters	
		The first	The second
Ch pulv	*Saxifraga porophylla*	Elevation *(+)	Soil type-1 *(-)
Ch suffr	*Cerastium tomentosum*	NDVI (-)	Incoming spring solar radiation (+)
	Cerastium thomasii	Elevation (+)	Soil type-4 (+)
H caesp	*Achillea barrelieri* subsp. *barrelieri*	Elevation (+)	Slope (-)
	Festuca violacea subsp. *italica*	Elevation (+)	NDVI (-)
H ros	*Armeria majellensis* subsp. *majellensis*	Elevation (+)	NDVI (-)
H scap	*Centaurea tenoreana*	Slope (+)	Incoming summer solar radiation (-)
	Silene notarisii	Slope (+)	**Soil type-4 (+)
	Adonis distorta	Elevation (+)	NDVI (-)

* :(+) means the coefficient value is positive, and (-) means the coefficient value is negative.

**:Soil type-4” is Limestone and marls.

5.3. Endemic Plant taxa Distribution

Because of the poor amount of database and time limitation of this research, this research only selected 2 endemic plant taxa for predicting the distribution. They are *Achillea barrelieri* subsp. *barrelieri* and *Adonis distorta.* The results were shown below.

5.3.1. *Achillea barrelieri* subsp. *barrelieri*

Achillea barrelieri subsp. *barrelieri* has 18 present records, and all of them are on the high elevation part of Majella massif. Through the pseudo-absence process the pseudo-absence records were generated. After combining present records and pseudo-absence records, this database has been a presence/absence geodatabase. This combined geodatabase of *Achillea barrelieri* subsp. *barrelieri* is in Table E in Appendices.

After using Indicator kriging, the distribution map of *Achillea barrelieri* subsp*. barrelieri* was predicted (Fig. 5-14). The map shows the high probability of distribution part is on the high elevation part of Majella massif, and this result fit the distribution of present records. Comparing this distribution map with habitat-suitability map of *Achillea barrelieri* subsp*. barrelieri* (Fig. 5-11), even though the Majella massif is also a core habitat, there still are some core habitat in the west part.

5.3.2. *Adonis distorta*

There are 13 present records of *Adonis distorta* in the geodatabase. Table F in appendices is the combining geodatabase of present records and pseudo-absence records. After using Indicator kriging, the distribution map of *Adonis distorta* was predicted (Fig. 5-15). The present records are on the high altitude part of Majella massif, and the high probability of *Adonis distorta* distribution is in the same part. However, comparing this result to the habitat-suitability map (Fig. 5-7), the result is also different. The core habitat still is in the high altitude part of Majella massif, but the predicted habitat-suitability map also shows the low marginal habitat in the North-west part of Majella National Park, i.e. the Mount Morrone.

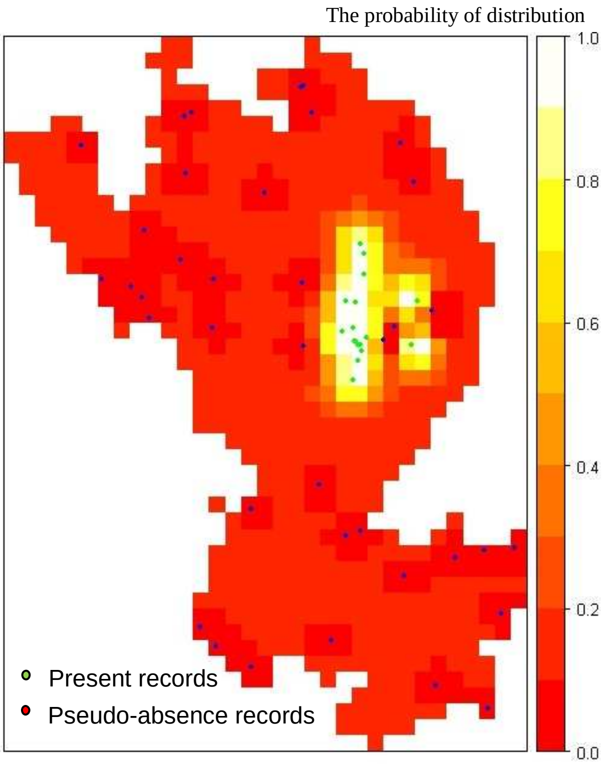


Fig. 5-14 The distribution map of *Achillea barrelieri* subsp. *barrelieri* in Majella National Park

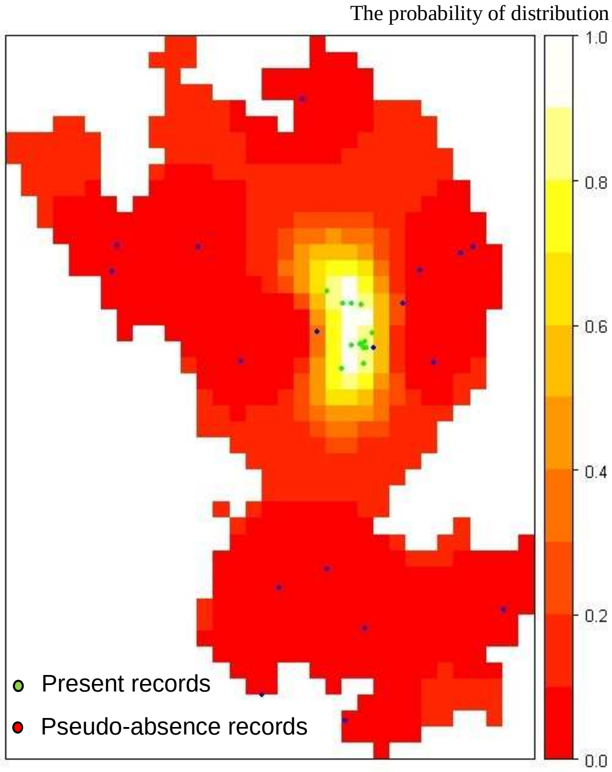


Fig. 5-15 The distribution map of *Adonis distorta* in Majella National Park

6. Discussion

6.1. Database

In the point of endemic plant taxa geodatabase, there are two aspects which can be discussed in this research. The first issue is the application of secondary data. The second issue is the spatial accuracy of this geodatabase.

6.1.1. Secondary data of endemic plant taxa

The great problem of using secondary data is the correctness and the accuracy. The endemic plant taxa records were collected from 1811 to 2008, and some of the plant taxa may not be present in that location anymore. However, in the aspect of man-made interference Majella National Park has done constructive conservation so the human-effect is less. The climate change causes a temperature increase and an increase of rainfall (Stanisci, et al., 2005). Some research approved climate change causes the variation of vegetation distribution(Dai, 2010; Stanisci, et al., 2005). Furthermore, this research does not contain the primary data for accuracy assessment.

6.1.2. Spatial accuracy

In the aspect of spatial accuracy, building a spatial accuracy system for a geodatabase is necessary. This research used Fabio Conti's spatial accuracy system. Fabio Conti's database contributed more than 1,000 records with toponomy and its assigned spatial coordinates. Comparing with Fabio Conti's database, it is sufficient to assign spatial coordinators for the records with toponomy. Besides this, there is a spatial accuracy system with four levels in Fabio Conti's database. This system made this research to build a reliable spatial accuracy system.

This research only used level-one and level-two plant taxa records. The resolution of the environmental layers was limited to 1Km pixel size. The amount of level-one and level-two records is small. The resolution reductive made the available records fewer because sometimes more than one records will become only one grid with 1Km resolution when transforming to Idrisi format. These limited the ability of modelling. That is the reason *Pedicularis elegans* can not build a reliable model for predicting habitat-suitability map. It can be discussed whether level-three records are good enough for modelling, and whether the resolution with less than 1Km is also acceptable for modelling in using level-one and level-two records situation. There is a research (Nanyomo, 2010) which used the same database for modelling endemic plant taxa. In this research records with level-one to level-three accuracy were used, and the spatial resolution of the environmental layers was 30m. The AUC of the result is more than 80, and this expresses this condition can also well predict the endemic plant taxa with this database.

6.2. Endemic plant taxa suitable habitat

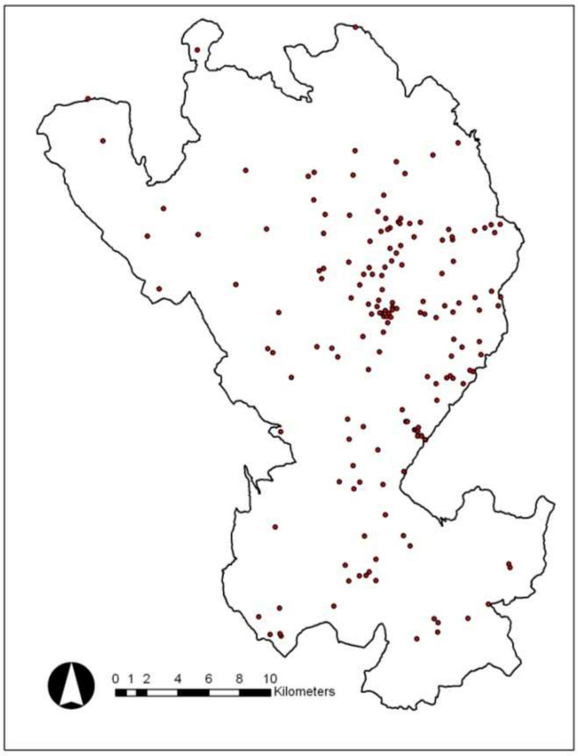
From ENFA endemic plant taxa habitat-suitability map of each taxa can be predicted. In the principle this map will contribute a reliable potential distribution from environmental parameters. However, in the results of this research the ability to predict true absence place is acceptable, but for some taxa there is no present record in high potential parts. Taking *Cerastium thomasii* for an instance, all present records are in the Majella massif and in the high altitude part, and this fits its habitat-suitability map (Fig. 5-10). For *Festuca violacea* subsp. *italica*, all present records are also in the Majella massif, but in its habitat-suitability map (Fig. 5-12) Majella massif is one of its high potential distribution parts. The Mountain Morrone is also its high potential distribution part. This is not a single case of this research. For this result, there are some possible reasons.

1) Most present records are collected from Majella massif.

This research used secondary geodatabase collected from literatures and herbarium. In the literatures most of the researches are in the Majella massif so the proportion of the records collected in the other parts is less. Besides this, the secondary geodatabase only includes present records. These must be a limitation for supporting the results of ENFA. Even though the endemic plant taxa is there indeed, the records can not confirm the habitat-suitability map.

2) Some records were deleted because of the low spatial accuracy.

This research only selected level-one and level-two for analysis. That is possible that some records out of Majella massif are level-three spatial accuracy so they were deleted in the clean work. Fig. 6-1 shows the records with level-one and level-two spatial accuracy, and Fig. 6-2 shows records with level-one, level-two and level-three spatial accuracy. Comparing of these two maps, the decrease of the number of records which are out of Majella massif can be realised.



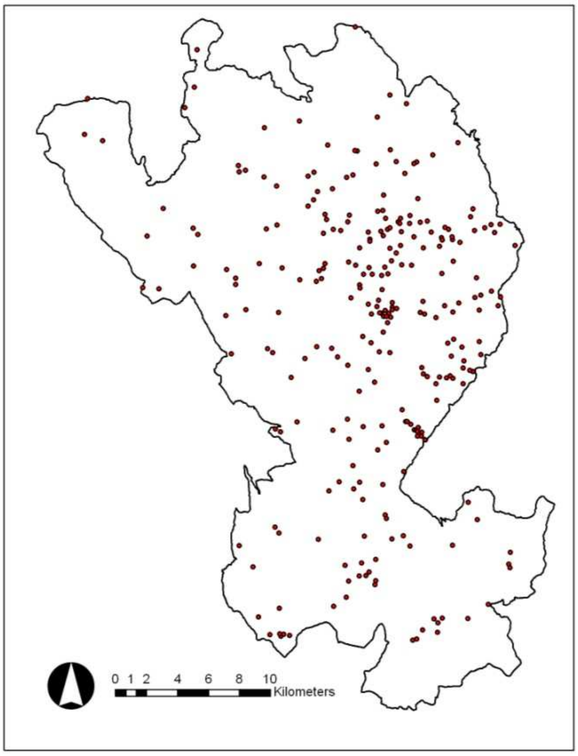


Fig. 6-1 The records with level-one and level-two spatial accuracy

Fig. 6-2 The records with level-one, level-two and level-three spatial accuracy

3) The resolution of the grid is too small.

ENFA is computed in every grid so the value of every grid is sensitive to the whole research area. This research reduced the resolution of each grid to 1Km. For environmental parameters some fine distinction which is smaller than 1Km and is an explanatory environmental factor was disappeared, and for endemic plant taxa records the area of its suitable habitat is smaller than 1 grid.

4) A habitat-suitability map is an optimistic prediction.

Habitat-suitability map reflects the effect of environment and expresses the potential of distribution. A research expressed ENFA tends to generate over-optimistic prediction. It means this analysis can predict too many locations (Engler, et al., 2004). Besides this, from the habitat-suitability map the high potential distribution place can be known, but for some historical reasons or some human activities this endemic plant taxa may not be there or may not be there anymore.

6.3. Endemic plant taxa distribution

6.3.1. Comparing habitat-suitability maps with distribution maps

Taking *Adonis distorta* for example, Fig. 5-7 is its habitat-suitability map, and Fig. 5-15 is its distribution map. Both maps expressed the high suitability of habitat (Fig. 5-7) and high probability of distribution (Fig. 5-15) in the high altitude part in the Majella massif, and this means these two maps can get identical prediction in high suitability and high probability part. However, the low marginal habitat in the Mount Morrone is low probability of distribution.

The distribution map was predicted by present observations and pseudo-absence data and without environmental parameters through Indicator kriging. According to endemic plant geodatabase, even including the level-three spatial accuracy records, there is no present record in the Mount Morrone so it is low probability of distribution. However, as mentioned above (Engler, et al., 2004) a habitat-suitability map is an optimistic prediction. According to the present records and environmental parameters the prediction expresses the potential location for the distribution. Comparing to the endemic plant geodatabase of this research, the predicted habitat in the Mount Morrone is an error. Comparing to the relevant research, *Adonis distorta* restrictedly tends to grow at the limestone massifs of the Central Apennines such as Majella, Gran Sasso, Sirente, Vettore, Velino and Monti della Duchessa, and the souther limit is at Mount Morrone (Pietro, et al., 2008). This conforms Mount Morrone is also a distribution location. Fig. 6-3 is the distribution map in Pietro's research (2008).

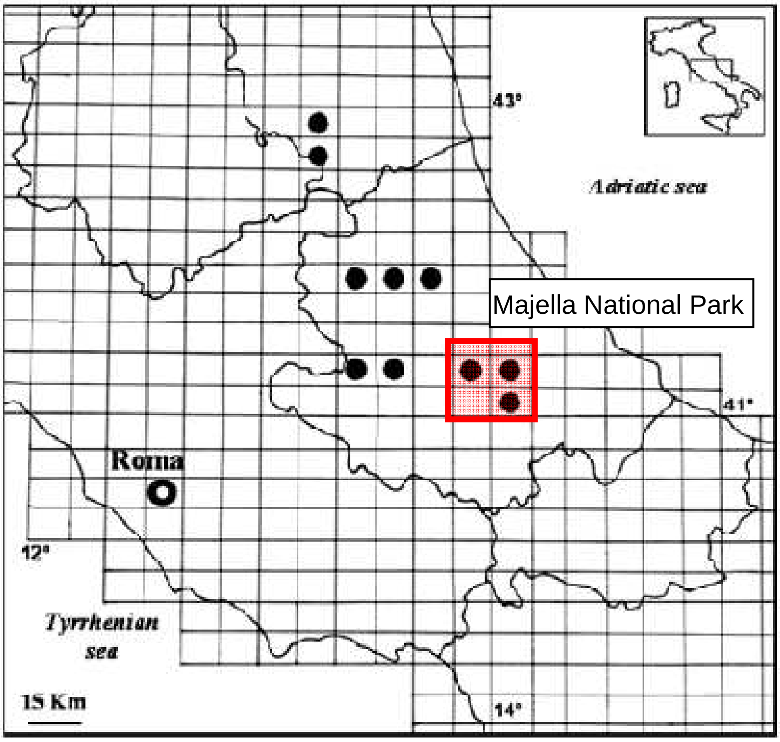


Fig. 6-3 The distribution map of *Adonis distorta* (Pietro, et al., 2008) (Modified by this research)

There is no critical judgement to weight whether habitat-suitability model is better than Indicator kriging, because the motivation of predicting maps is different. Habitat-suitability model is an optimistic model and can contribute good result in potential location, even though the number of present data is not much (< 20). On the other hand, for the current geodatabase Indicator kriging can contribute prediction faithfully with combining the present data and pseudo-absence data, but the result can not be extended. That is because Indicator kriging only consider the relation between any two points without environmental parameters. Besides this reason, the different between two models may be caused by the limitation of poor current database, because in fitting the variograms the number of points which is smaller than 150 will gives very unreliable variograms (Webster & Oliver, 2008).

6.3.2. Endemic plant taxa distribution patterns

The endemic plant taxa geodatabase and the habitat-suitability model exhibited most of the endemic plant taxa tend to be distribution in the high altitude part above the timberline, especially on the high altitude part of Majella massif. This result is the same as Pietro (2008) and Casazza (2005) Because of the low temperature and long-term snow persistence (7-8 months a year)((Stanisci, et al., 2005)), these place are bare or high-elevation pasture. The reason may be inferred to human-effect, glacial refugia, archipelago nature of high mountains, the high habitat diversity and the small size of alpine plants (G. Casazza, et al., 2005; Gabriele Casazza, et al., 2008; Korner, 2008; Schonswetter, et al., 2005).

The plant distribution patterns can be influenced by historical factors and land use diversity (G. Casazza, et al., 2005). The first inference is these endemic taxa has large range of distribution and can also be distribution under the timberline. Nevertheless, the demand for land of human decreases the habitat of these taxa. Therefore, these taxa are only present in the inaccessible place, high altitude place.

The upper part of Majella massif was covered by the ice layer with more than 200m thick in the last glacial maximum (Stanisci, et al., 2005). There should be some glacial refugia in the range of Majella National Park, and some survival in the glacial refugia would like to spread and migrate. Due to the climate restriction, the migration was not success. When the weather became warm in the lowland, the trees become the dominant taxa in the lowland, and these taxa kept in the place with the cold and dry climate (Schonswetter, et al., 2005).

Korner (2008) mentioned 3 reasons of high species richness of high mountains. The archipelago nature of high mountains is caused by a fragmentation into climatic islands. The high habitat diversity is caused by severe weather change. The small size of alpine plants increases the living ability in the changeable environment.

7. Conclusion and Recommendation

7.1. Endemic Plant Taxa Geodatabase

The limitation of using secondary endemic plant geodatabase from multi-sources can be generalized in to 4 aspects in this research, and all of them were overcome by technical methods. The coordinate system (projection) in multiple-source can be transferred with ArcGIS and ERDAS operations. Using the Fabio Conti's database and his special accuracy system, the records without coordinators can be assigned to points, and spatial accuracy of the XY coordinates also can be build. Furthermore, this research used habitat-suitability index to deal with presence-only geodatabase problem. This research also used habitat-suitability index as weight to generate pseudo-absence records from unsuitable habitat. After combining the pseudo-absence and presence-only data, this geodatabase can be used for modelling.

7.2. Modelling Endemic Plant Taxa Distribution With Presence-Only Data

There are many researches proved presence-only data can overcome the shortcoming and predict acceptable distribution maps. This research has successful predicted habitat-suitability maps and distribution maps from presence-only data. Besides, the most explanatory environmental parameter is in accordance with the research of Pietro (2008) and Casazza (2005).These result can encourage more research which only depends on secondary geodatabases or presence-only data to solve more research problem.

7.3. Majella National Park as an endemic plant biodiversity hotspot at the Mediterranean-basin scale

From the literature review the two criteria to identify a hotspot are species endemism and degree of threat (Myers, 2001). The endemic plant taxa geodatabase used in the research confirmed there are 146 endemic plant taxa of Italy in Majella National Park which is only 74,095 Ha, 740.95 Km^2. Furthermore, 87 of 146 endemic plant taxa are rare in the world, and 15 of 146 endemic plant taxa are even extremely rare (Pignatti, 1982). It expresses Majella National Park has high density of endemic plant taxa. In the aspect of threatens there are some grazing activities, forest fire events and climate change crises from the relevant research conducted in the Majella National Park (Dai, 2010; van Gils, et al., 2008), and the synergism of these threatens can cause serious effect in the Park. From these two points Majella National Park should be an endemic plant biodiversity hotspot at the Mediterranean-basin scale.

7.4. Recommendation

The endemic plant taxa used in this research only included level-one and level-two spatial accuracy rerecords, and this made the poor amount of geodatabase. From relevant research used the same spatial accuracy system, also using level-three records can show good result. Further research can use the same spatial accuracy system and exam how the level of spatial accuracy affect the prediction.

In the result park this research successfully predicted distribution maps with Indicator Kriging. Because of the time limitation and poor amount of geodatabase, this research only selected some taxa with more present records to be predicted. Although in the discussion a suspicious was showed, the potential of the modelling ability of ENFA and Indicator kriging can be expected. Further research can collect more primary databases and try to prove its ability.

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Appendices

Table A Endemic plant taxa list with checklist code

*Checklist code	**No. of Flora d'Italy	***Taxa
591	419	Arenaria bertolonii Fiori
621	NEW	Minuartia glomerata (M. Bieb.) Degen subsp. trichocalycina (Ten. & Guss.) F. Conti
628	447	Minuartia graminifolia (Ard.) Jáv. subsp. rosani (Ten.) Mattf.
674	475	Cerastium tomentosum L.
682	478	Cerastium thomasii Ten.
683	479	Cerastium scaranii Ten.
768	****NEW	Herniaria bornmuelleri Chaudhri
816	576	Silene roemeri Friv. subsp. staminea (Bertol.) Nyman
836	589	Silene notarisii Ces.
894	584	Silene cattariniana Ferrarini & Cecchi
935	649	Dianthus vulturius Guss. & Ten. subsp. vulturius
937	650	Dianthus ferrugineus Mill.
943	651	Dianthus carthusianorum L. subsp. tenorei (Lacaita) Pignatti
994	675	Helleborus bocconei Ten. subsp. bocconei
1075	732	Adonis distorta Ten.
1099	749	Ranunculus pollinensis (N. Terracc.) Chiov.
1100	750	Ranunculus apenninus (Chiov.) Pignatti
1150	793	Ranunculus magellensis Ten.
1198	829	Aquilegia magellensis F. Conti & Soldano
1225	847	Paeonia officinalis L. subsp. italica N.G. Passal. & Bernardo
1355	950	Erysimum majellense Polatschek
1357	952	Erysimum pseudorhaeticum Polatschek
1421	1000	Cardamine apennina Lihová & Marhold
1432	NEW	Cardamine monteluccii Brilli-Catt. & Gubellini
1443	1026	Arabis collina Ten. subsp. rosea (DC.) Minuto
1462	1038	Aubrieta columnae Guss. subsp. columnae
1471	NEW	Ptilotrichum rupestre (Ten.) Boiss. subsp. rupestre
1562	1116	Thlaspi stylosum (Ten.) Mutel
1591	1130	Biscutella laevigata L. subsp. australis Raffaelli & Baldoin
1730	1228	Sempervivum riccii Iberite & Anzal.
1759	1249	Sedum magellense Ten. subsp. magellense
1812	1282	Saxifraga italica D.A. Webb
1819	1285	Saxifraga exarata Vill. subsp. ampullacea (Ten.) D.A. Webb
1838	1301	Saxifraga oppositifolia L. subsp. speciosa (Dörfl. & Hayek) Engl. & Irmsh.
1851	1314	Saxifraga porophylla Bertol. subsp. porophylla
2049	1452	Potentilla rigoana Th. Wolf
2374	1658	Astragalus aquilanus Anzal.
2394	1666	Oxytropis pilosa (L.) DC. subsp. caputoi (Moraldo & La Valva) Brilli-Catt., Di Massimo & Gubellini
2496	1744	Lathyrus odoratus L.
2518	1763	Ononis cristata Mill. subsp. apennina Tammaro & Catonica
2542	1783	Ononis oligophylla Ten.
2660	1879	Trifolium pratense L. subsp. semipurpureum (Strobl) Pignatti
2808	1974	Geranium austroapenninum Aedo
2845	2010	Erodium alpinum L'Hér.

Continue Table A

Checklist code	No. of Flora d'Italy	Taxa
2913	2067	Euphorbia gasparrinii Boiss. subsp. samnitica (Fiori) Pignatti
3037	2155	Acer cappadocicum Gled. subsp. lobelii (Ten.) Murray
3187	2262	Viola magellensis Porta & Rigo ex Strobl
3206	2273a	Viola eugeniae Parl. subsp. eugeniae
3207	2273b	Viola eugeniae Parl. subsp. levieri (Parl.) Arcang.
3420	2409	Astrantia pauciflora Bertol. subsp. tenorei (Mariotti) Bechi & Garbari
3443	2429	Chaerophyllum hirsutum L. subsp. magellense (Ten.) Pignatti
3471	2450	Bunium petraeum Ten.
3551	2519	Bupleurum gussonei (Arcang.) S. & B. Snogerup
3597	2556	Carum flexuosum (Ten.) Nyman
3604	2562	Coristospermum cuneifolium (Guss.) Bertol.
3659	2596	Laserpitium siler L. subsp. siculum (Spreng.) Santangelo, F. Conti & Gubellini
3796	2677	Androsace vitaliana (L.) Lapeyr. subsp. praetutiana (Sünd.) Kress
3801	2696	Soldanella minima Hoppe subsp. samnitica Cristof. & Pignatti
3832	2726	Armeria denticulata (Bertol.) DC.
3844	2724	Armeria majellensis Boiss. subsp. majellensis
3846	2725	Armeria seticeps Rchb.
4049	2826	Gentianella columnae (Ten.) Holub
4103	2868	Asperula cynanchica L. subsp. neglecta (Guss.) Arcang.
4138	2894	Galium lucidum All. subsp. venustum (Jord.) Arcang.
4162	2916	Galium magellense Ten.
4268	2994	Onosma echioides (L.) L.
4309	NEW	Pulmonaria apennina Cristof. & Puppi
4364	3050	Myosotis ambigens (Bég.) Grau
4383	3070	Cynoglossum magellense Ten.
4386	3071	Solenanthus apenninus (L.) Fisch. & C.A. Mey.
4415	3088	Ajuga tenorei C. Presl
4464	3120	Sideritis italica (Mill.) Greuter & Burdet
4508	3152	Ballota hispanica (L.) Benth.
4516	3154	Stachys alopecuros (L.) Benth. subsp. divulsa (Ten.) Grande
4581	3206	Micromeria graeca (L.) Benth. ex Rchb. subsp. tenuifolia (Ten.) Nyman
4676	3270	Salvia haematodes L.
4754	3321	Verbascum niveum Ten. subsp. garganicum (Ten.) Murb.
4762	3325	Verbascum argenteum Ten.
4763	NEW	Verbascum magellense Ten.
4815	3373	Linaria purpurea (L.) Mill.
4839	3386	Cymbalaria pallida (Ten.) Wettst.
4841	3387	Cymbalaria glutinosa Bigazzi & Raffaelli subsp. glutinosa
4859	3397	Digitalis lutea L. subsp. australis (Ten.) Arcang.
4931	3455	Melampyrum italicum Soó
4998	3499	Pedicularis elegans Ten.
5001	3513	Rhinanthus wettsteinii (Sterneck) Soó
5046	3546	Orobanche ebuli Huter & Rigo
5088	3577	Pinguicula fiorii Tammaro & Pace
5249	3711	Scabiosa holosericea Bertol.
5256	3703	Scabiosa uniseta Savi
5265	NEW	Lomelosia crenata (Cirillo) Greuter & Burdet subsp. pseudisetensis (Lacaita) Greuter & Burdet
5321	3746	Campanula fragilis Cirillo subsp. cavolinii (Ten.) Damboldt
5336	3759	Campanula tanfanii Podlech

Continue Table A

Checklist code	No. of Flora d'Italy	Taxa
5339	3761	Campanula micrantha Bertol.
5354	3755	Asyneuma trichocalycinum (Ten.) K. Malý
5448	3837	Bellis pusilla (N. Terracc.) Pignatti
5603	3947	Anthemis arvensis L. subsp. sphacelata (C. Presl) R. Fern.
5609	3937a	Anthemis cretica L. subsp. alpina (L.) R. Fern.
5611	3937b	Anthemis cretica L. subsp. petraea (Ten.) Oberpr. & Greuter
5633	3961	Achillea barrelieri (Ten.) Sch. Bip. subsp. barrelieri
5634	3960	Achillea barrelieri (Ten.) Sch. Bip. subsp. mucronulata (Bertol.) Heimerl
5662	3981	Achillea tenorii Grande
5674	3993	Leucanthemum tridactylites (A. Kern. & Huter) Huter, Porta & Rigo
5684	4005	Leucanthemum coronopifolium Vill. subsp. tenuifolium (Guss.) Vogt & Greuter
5769	4071	Senecio ovatus (P. Gaertn., B. Mey. & Scherb.) Willd. subsp. stabianus (Lacaita) Greuter
5812	NEW	Senecio apenninus Tausch
5825	4059	Tephroseris italica Holub
5850	4116	Carduus nutans L. subsp. perspinosus (Fiori) Arènes
5870	4129	Carduus affinis Guss. subsp. affinis
5874	4131	Carduus corymbosus Ten.
5892	4151	Cirsium lobelii Ten.
5919	4149	Cirsium tenoreanum Petr.
5970	4205	Centaurea rupestris L. subsp. ceratophylla (Ten.) Gugler
6049	4241	Centaurea nigrescens Willd. subsp. neapolitana (Boiss.) Dostál
6074	4229b	Centaurea ambigua Guss. subsp. ambigua
6075	4229a	Centaurea ambigua Guss. subsp. nigra (Fiori) Pignatti
6076	4229c	Centaurea ambigua Guss. subsp. laciniata (Guss.) Arcang.
6078	4231	Centaurea tenoreana Willk.
6102	4198	Rhaponticoides centaurium (L.) M.V. Agab. & Greuter
6146	4285	Echinops ritro L. subsp. siculus (Strobl) Greuter
6218	4340	Robertia taraxacoides (Loisel.) DC.
6224	4344	Leontodon montanus Lam. subsp. breviscapus (DC.) Cavara & Grande
6240	4352	Leontodon intermedius Porta
6260	4370	Taraxacum glaciale E. & A. Huet ex Hand.-Mazz.
6561	NEW	Hieracium acanthodontoides Arv.-Touv. & Belli
6568	NEW	Hieracium profetanum Belli
6659	4470	Hieracium grovesianum Arv.-Touv. ex Belli
6762	4564	Colchicum alpinum Lam. & DC. subsp. parvulum (Ten.) Arcang.
6833	4621	Ornithogalum exscapum Ten.
6842	4615	Ornithogalum orthophyllum Ten.
6933	NEW	Allium calabrum (N. Terracc.) Brullo, Pavone & Salmeri
7029	4744	Iris marsica I. Ricci & Colas.
7138	4836	Luzula sicula Parl.
7257	4923	Festuca violacea Schleich. ex Gaudin subsp. italica Foggi, Graz. Rossi & Signorini
7291	4931	Festuca inops De Not.
7334	4959	Sesleria nitida Ten.
7522	5078	Avenula praetutiana (Parl. ex Arcang.) Pignatti
7569	NEW	Trisetaria villosa (Bertol.) Banfi & Soldano
7723	5210	Stipa dasyvaginata Martinovský subsp. apenninicola Martinovský & Moraldo
8109	NEW	Ophrys promontorii O. & E. Danesch
8112	5520	Ophrys sphegodes Mill. subsp. garganica E. Nelson
8124	5518	Ophrys bertoloniiformis O. & E. Danesch

Continue Table A

Checklist code	No. of Flora d'Italy	Taxa
8134	5522	Ophrys fuciflora (F.W. Schmidt) Moench subsp. apulica O. & E. Danesch
8140	NEW	Ophrys crabronifera Mauri
8235	NEW	Epipactis meridionalis H. Baumann & R. Lorenz
8270	4067	Senecio scopolii Hoppe & Hornsch. ex Bluff & Fingerh. subsp. floccosus (Bertol.) Greuter

* : "Checklist code" is adopted from "An Annotated Checklist of the Italian Vascular Flora" (Giovanna, et al., 2005).

** : "No. of Flora d'Italy" is adopted from "Flora d'Italy" (Pignatti, 1982).

*** :"Taxa" is plant nomenclature which is adopted from "An Annotated Checklist of the Italian Vascular Flora" (Giovanna, et al., 2005).

**** :"New" means this taxa is not defined in "Flora d'Italy" (Pignatti, 1982).

Table B The character of endemic plant taxa in Majella National Park

Checklist code	Habitat (Italian)	Life form	Altitude		Flowering (month)	Rare
			Low	high		
591	Ghiaioni calcarei	Ch suffr	1000	2300	6 - 8	
628	Sfasciume calcareo e rupi	Ch suffr	1600	2200	6 - 7	R
674	Ghiaioni, macereti, pendii rupestri (calc.)	Ch suffr	600	2200	6 - 8	
682	Rupi calc.	Ch suffr	1700	2900	7 - 8	R
683	Pendii aridi, anche rupestri(calc.)	H scap	600	1450	4 - 7	
816	Pascoli alpini	H ros	1300	1800	6 - 7	
894	Rupi e pietrate(calc.)	H scap	900	2000	6 - 7	R
836	Rupi ombrose.	H scap	900	1900	5 - 7	R
935	Prati aridi, boscaglie	H scap	500	1200	6 - 7	R
937	Prati aridi, boscaglie	H scap	500	1200	6 - 8	R
943	Prati aridi (calc.)	H scap	1	2000	5 - 8	
994	Cedui, boschi submediterranei schiariti, siepi.	G rhiz	1	1700	2 - 4	
1075	Brecciai e rupi (caic.)	H scap	2000	2005	7 - 8	R
1099	Macereti calc. Soleggiati	Rz.	1800	2400	7 - 8	R
1100	Pascoli d'alititudine (silice e calc.)	Rz.	1800	2500	5 - 7	R
1150	Vallette nivali (calc.)	H scap	2000	2600	7 - 8	R
1198	Rupi calc. E stillicidiose.	H scap	1000	1500	6 - 7	RR
1225	Boschi chiari di latifoglie	G rhiz	100	1800	5 - 6	R
1355	Pendii steppici e rupestri, prati aridi (calc.)	H scap	1100	2400	6 - 8	R
1357	Pietraie, pascoli aridi, vigne, vecchi muri e lungo le vie	H scap	100	900	4 - 6	
1421	Prati umidi torbosi, boschi igrofili	H scap	1	1700	5 - 7	R
1443	Pascoli e rupi su calc. E suolo vulcanico	H scap	100	1600	2 - 5	R
1462	Rupi calc.	Ch suffr	800	2300	5 - 6	
1562	Pascoli subalpini (calc.)	Ch suffr	1800	2450	5 - 6	R
1591	Prati aridi soleggiati, pascoli, rupi (calc.)	H scap/H ros	1	2700	4 - 8	
1730	Rupi calc.	Ch succ	1500	2000	7 - 8	RR
1759	Rupi ombrose, forre (calc.)	Ch succ	1400	2200	7 - 8	
1812	Rupi e sfatticcio calc.	Ch pulv	2000	2500	7 - 8	R
1819	Rupi, sgretolantisi, sfatticcio (calc.)	H scap	1900	2600	7 - 7	RR
1838	Ghiaie, sfatticcio calc.	Ch pulv	2000	2700	7 - 8	RR
1851	Rupi compatte o sgretolantisi (calc.)	Ch pulv	1200	2000	6 - 6	RR
2049	Prati aridi (calc.)	H scap	1	1500	4 - 9	R
2374	Prati aridi (calc.)	H scap/Ch suffr	800	1000	5 - 6	R
2394	Pascoli di vetta. Creste (calc.)	H scap	900	2200	6 - 7	R
2496	Incolti aridi argillosi.	T scap	1	600	6 - 8	
2518	Pascoli aridi.	G rhiz	600	700	5 - 8	R
2542	Incolti aridi ed argillose	T scap	1	1100	5 - 7	
2660	Pascoli subalpini sull'app. Centro-merid. Ed in sic.	H scap	1	2600	1 - 12	
2808	Ghiaie, rupi di vetta.	H ros	1700	2200	7 - 8	R
2845	Pascoli aridi (calc.)	Ch suffr	1300	1800	6 - 7	R
2913	Prati umidi montani	Ch suffr	800	1850	5 - 6	
3037	Boschi montani	P scap	750	1700	5 - 5	R
3187	Ghiaioni e brecciai calc.	H scap	2400	2800	6 - 8	RR
3420	Rupi calc.	H scap	1200	2000	7 - 8	R
3443	Cespuglieti subalpini	H scap	200	2400	6 - 8	R
3471	Prati e pascoli montoni	G bulb	1200	1800	7 - 8	R
3551	Pascoli aridi, garighe, macchie (calc.)	T scap	1	1400	4 - 8	
3597	Rupi e pietrate calc.	H scap	1600	2400	6 - 7	R
3604	Dirupi, pietraie (calc.)	H scap	150	2450	6 - 7	RR

Continue Table B

Checklist code	Habitat (Italian)	Life form	Altitude		Flowering (month)	Rare
			Low	high		
3659	Pendii aridi rupestri, prati aridi montani.	H scap	200	2400	5 - 8	RR
3796	Rupi, creste, pascoli alpini	Ch suffr	2200	2800	6 - 7	R
3801	Vallette nivali su calc.	H ros	1900	2500	6 - 7	R
3844	Prati e pascoli su calc.	H ros	1800	2900	8 - 9	R
3846	Pascoli pietrosi, rupi.	H ros	1500	2000	7 - 8	R
3832	Rupi e pascoli sassosi su serpentino	H ros	100	600	5 - 8	R
4049	Pascoli aridi subalpini	H bienn	1500	2200	6 - 7	R
4103	Rupi e pascoli sassosi (calc.)	H scap	800	2400	6 - 8	R
4138	Rupi e sfatticcio calc.		1	1600	7 - 9	R
4162	Ghiaie calc.	H scap	1800	2600	6 - 8	R
4268	Pendii aridi xerotermici e stazioni rupestri	Ch suffr	1	1500	6 - 7	R
4364	Pascoli alpini lungam innevati	H scap	1200	2450	5 - 7	R
4383	Pascoli aridi (calc.)	Ch suffr	2000	2007	6 - 7	R
4386	Boscaglie pascoli	H bienn	800	2000	5 - 7	
4415	Boschi sassosi (calc.)	H ros	1200	2200	5 - 6	R
4464	Garighe, prati aridi, spesso in estesi popolamenti (calc.)	Ch suffr	1500	1950	5 - 7	
4508	Rupi ombrose, forre (calc.)	Ch frut	1	1500	4 - 8	RR
4516	Pascoli subalp., prati aridi, rupi. Su calc.	H scap	300	2300	6 - 8	
4581	Rupi, pietraie, pascoli.	Ch suffr	1	1200	5 - 6	
4676	Prati aridi.	H scap	1	1600	5 - 8	
4754	Pascoli aridi.	H bienn	1	1000	6 - 8	R
4762	Luoghi aridi	H bienn	1000	1800	7 - 8	RR
4815	Rupi, pietraie, incolti.	H scap	1	1900	4 - 10	
4839	Ghiaioni montani	H scap	1500	2500	6 - 8	R
4841	Rupi calc.	Ch rept	1	300	4 - 8	R
4859	Radure boschive. Cedui.	H scap	800	1500	6 - 7	
4931	Boschi di latifoglie (quercete, faggete). Cedui, cespuglieti	T scap	1	1400	5 - 8	R
4998	Pascoli subalpini e zolle piontere (calc.)	H ros	1400	2400	5 - 6	R
5001	Pascoli d'altitudine.		1300	2400	7 - 8	R
5046	Su Galium ed altre Rubiacee	T par	1	1500	4 - 7	R
5088	Rupi calc. Stillicidiose, fessure ombrose	H ros	400	1600	4 - 6	RR
5256	Prati aridi, boscaglie	H scap	1	1800	5 - 8	
5249	Prati aridi, pendii stepposi pietraie (calc.. Serpentini)	H scap	500	1900	6 - 7	R
5321	Rupi, vecchi muri.	Ch suffr	500	1300	6 - 9	R
5354	Boschi di latifoglie, soprattutto faggete.	H scap	1500	1900	6 - 7	R
5336	Rupi calc. Ombrose e umide	H scap	150	2000	5 - 9	R
5339	Pendii aridi selve	H scap	1000	1800	7 - 8	RR
5448	Pascoli lungam innevati	H ros	2100	2600	7 - 8	R
5603	Colture di cereali, pascol e terreni abbandonati (prefer, silice)	T scap(H scap)	1	1800	4 - 6	
5634	Macereti calc.	H scap	1000	2000	6 - 7	
5633	Ghiaie consolidate, zolle pioniere.	H caesp	2000	2600	7 - 8	
5662	Pascoli montani	H scap	1000	2200	7 - 9	R
5674	Praterie pseudoalpine, pendii rupestri, fenditure delle rocce (calc.)	H scap	1500	2200	7 - 8	R
5684	Prati sassosi e ghiaioni (calc.)	H scap	1500	2400	6 - 8	R
5825	Selve e prati.	H ros	700	1800	6 - 7	R
8270	Prati aridi e pascoli (calc.)	H ros	800	2000	5 - 8	R
5769	Boschi umidi, forre.	H scap	800	2200	7 - 8	
5850	Incolti aridi.	H bienn	1	1500	6 - 8	R

Continue Table B

Checklist code	Habitat (Italian)	Life form	Altitude		Flowering (month)	Rare
			Low	high		
5870	Pascoli, recinti per gli armenti, boscaglie.	H scap	1500	2200	6 - 8	
5874	Incolti aridi, macerie, lungo le vie.	T scap	1	600	4 - 6	
5919	Pascoli, incolti, lungo le vie.	H bienn	1000	1800	7 - 9	
5892	Pascoli, incolti, lungo le vie.	H bienn	1000	2000	6 - 9	R
6102	Boschi di latifoglie (quercete, faggete)	H scap	500	1500	6 - 7	R
5970	Ambienti aridi sul calc.	H scap	500	1600	6 - 7	R
6078	Rupi calc.	H scap	1700	2000	7 - 8	RR
6049	Prati stabili, incolti.	H scap	1	1600	6 - 8	
6146	Boscaglie, cedui.	H scap	1	1500	6 - 8	
6218	Ghiaie , pascoli sassosi.	H ros	800	2500	5 - 8	
6224	Ghiaia, pendii franosi ed in soliflussione (calc.)	H ros	1800	2925	7 - 9	R
6240	Rupi e fessure (calc.)	H ros	400	2100	5 - 6	R
6260	Zolle erbose pioniere (calc.)	H ros	2000	2600	7 - 8	RR
6659	Boschi di latif. Ed aghifoglie, cespuglieti, pietraie	H scap	1	2000	5 - 8	R
6762	Prati aridi montani	G bulb	1	1800	7 - 9	RR
6842	Pascoli aridi sassosi.	G bulb	500	1800	5 - 6	RR
6833	Pascoli aridi	G bulb	1	1000	2 - 4	R
7029	Prati e cespuglieti.	G rhiz	1000	1700	5 - 6	R
7138	Peccete, brughiere subalpine a rododendri, generalm. Su terreni acidi	H caesp	1000	2100	6 - 7	R
7257	Pascoli alpini sul calc.	H caesp	1500	2600	6 - 8	R
7291	Rupi pascoli aridi (calc. Serpentini ed arenarie)	H caesp	1	1200	5 - 6	R
7334	Macereti pietraie consolidate (calc.)	H caesp	600	2000	6 - 7	R
7522	Pascoli montani	H caesp	1000	2000	6 - 7	
7723	Prati aridi steppici.	H caesp	1	800		
8124	Prati aridi, garighe, incolti	G bulb	1	1600	4 - 5	R
8112	Prati aridi, garighe, incolti	G bulb	1	1200	3 - 4	R
8134	Prati aridi, garighe	G bulb	500	1000	4 - 5	
3206	Catiche pioniere e pascoli sassosi d'altitudine su calc.	H scap	1500	2450	4 - 6	
3207	Catiche pioniere e pascoli sassosi d'altitudine su calc.	H scap	400	1000	4 - 6	
5609	Prati aridi sassosi (pref. Calc.)	H scap	1200	2600	6 - 8	
5611	Prati aridi sassosi (pref. Calc.)	H scap	1200	2600	6 - 8	
6075	Ambienti aridi (calc.)	H scap/H binn	1500	2500	6 - 8	
6074	Ambienti aridi (calc.)	H scap/H binn	1000	1628	6 - 8	
6076	Ambienti aridi (calc.)	H scap/H binn	1000	2500	6 - 8	

Table C The translation of life-form

Abbreviation	Life-form in Italian	Life-form in English
T caesp	Terofite cespitose	Therophytes cespitose
T rept	Terofite reptanti	Therophytes reptant
T scap	Terofite scapose	Therophytes scapose
T ros	Terofite rosulate	Therophytes rosulate
T par	Terofite parassite	Therophytes parasite
He	Elofite	Helophytes
I rad	Idrofite radicanti	Hydrophytes rooting
I nat	Idrofite natanti	Hydrophytes natnat
G rad	Geofite radicigemmate	Hydrophytes root-budding
G bulb	Geofite bulbose	Hydrophytes bulbose
G rhiz	Geofite rizomatose	Hydrophytes rhizomatose
G par	Geofite parassite	Hydrophytes parasite
H caesp	Emicriptofite cespitose	Hemicryptophytes caespitose
H rept	Emicriptofite reptanti	Hemicryptophytes reptant
H scap	Emicriptofite scapose	Hemicryptophytes scapose
H ros	Emicriptofite rosulate	Hemicryptophytes rosulate
H bienn	Emicriptofite bienni	Hemicryptophytes biennal
H scand	Emicriptofite scandenti	Hemicryptophytes scandent
Ch suffr	Camefite suffruticose	Chamaephytes suffruticose
Ch scap	Camefite scapose	Chamaephytes scapose
Ch succ	Camefite succulente	Chamaephytes succulent
Ch rept	Camefite reptanti	Chamaephytes reptant
Ch pulv	Camefite pulvinate	Chamaephytes pulvinate
Ch thall	Camefite tallofitiche	Chamaephytes thallophyte
Ch frut	Camefite fruticose	Chamaephytes fruticose
NP	Nano-Fanerofite	Nanophanerophytes
P caesp	Fanerofite cespugliose	Phanerophytes caespitose
P scap	Fanerofite arboree	Phanerophytes scapose
P lian	Fanerofite lianose	Phanerophytes lianose
P succ	Fanerofite succulente	Phanerophytes succulent
P ep	Fanerofite epifite	Phanerophytes epiphyte
P rept	Fanerofite striscianti	Phanerophytes reptant

Table D Presence-only geodatabase of endemic plant taxa

*Object ID	**Original ID	***Source	X	Y	Checklist code	Spatial accuracy
1	23	B	414540	4663749	591	3
2	10	B	430123	4654566	591	3
3	2	B	422199	4656508	591	2
4	13	B	422036	4667765	591	3
5	20	B	424415	4659651	591	3
6	21	B	422841	4664713	591	3
7	11	B	429003	4655166	591	3
8	4	B	424208	4655329	591	3
9	19	B	427040	4662048	591	3
10	1	B	428473	4663592	591	2
11	14	B	426466	4665310	591	3
12	15	B	425171	4657166	591	3
13	17	B	423281	4664093	591	3
14	3	B	419802	4639647	591	2
15	22	B	430664	4656747	591	3
16	33	B	424415	4659651	621	4
17	30	B	422199	4656508	621	2
18	32	B	417604	4667892	621	4
19	31	B	414540	4663749	621	3
20	34	B	434060	4664418	628	2
21	40	B	431592	4656490	628	3
22	38	B	426933	4664195	628	3
23	58	B	422841	4664713	628	3
24	35	B	427700	4661800	628	2
25	36	B	428473	4663592	628	2
26	56	B	427615	4663046	628	3
27	62	B	422036	4667765	628	3
28	37	B	429100	4662900	628	3
29	41	B	430707	4664077	628	3
30	39	B	414540	4663749	628	3
31	46	B	426466	4665310	628	3
32	48	B	426433	4660194	628	3
33	49	B	424415	4659651	628	3
34	52	B	429052	4638255	628	3
35	53	B	434595	4642478	628	3
36	83	B	414540	4663749	674	3
37	81	B	426933	4664195	674	3
38	80	B	407409	4672533	674	3
39	79	B	424208	4655329	674	3
40	82	B	429003	4655166	674	3
41	84	B	427897	4667704	674	3
42	86	B	420926	4651655	674	3
43	87	B	426433	4660194	674	3
44	88	B	424415	4659651	674	3
45	89	B	432807	4659850	674	3
46	90	B	417604	4667892	674	3
47	74	B	424194	4651835	674	2
48	99	B	418494	4661866	674	3
49	72	B	424296	4650546	674	2
50	73	B	408387	4669799	674	2
51	96	B	427040	4662048	674	3
52	75	B	419193	4637944	674	2
53	76	B	419885	4637843	674	2
54	77	B	418448	4639073	674	2
55	78	B	419802	4639647	674	2
56	92	B	432143	4664894	674	3
57	98	B	420446	4637887	674	3

Continue Table D

Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
58	103	B	430916	4662470	674	4
59	93	B	428318	4661776	674	3
60	94	B	430895	4655892	674	3
61	117	B	428473	4663592	682	3
62	123	B	414540	4663749	682	3
63	118	B	422841	4664713	682	3
64	115	B	424415	4659651	682	3
65	116	B	425171	4657166	682	3
66	120	B	427040	4662048	682	3
67	109	B	426400	4661100	682	2
68	110	B	425790	4661200	682	2
69	122	B	428318	4661776	682	3
70	129	B	425952	4654231	682	3
71	130	B	425724	4656765	682	3
72	126	B	426939	4656141	682	3
73	146	B	424415	4659651	768	4
74	152	B	434698	4643238	816	3
75	151	B	424208	4655329	816	3
76	153	B	426536	4666289	816	3
77	157	B	420926	4651655	836	3
78	155	B	421658	4667503	836	2
79	160	B	427061	4644123	836	3
80	166	B	430916	4662470	836	4
81	156	B	424296	4650546	836	2
82	159	B	434595	4642478	836	3
83	162	B	424722	4661770	836	3
84	163	B	431382	4659333	836	3
85	164	B	414540	4663749	836	3
86	165	B	422036	4667765	836	3
87	168	B	424208	4655329	894	3
88	170	B	430916	4662470	894	4
89	169	B	430664	4656747	894	3
90	171	B	424415	4659651	935	4
91	173	B	414540	4663749	937	3
92	176	B	424415	4659651	937	4
93	181	B	414540	4663749	943	3
94	177	B	426116	4671315	943	3
95	178	B	420926	4651655	943	3
96	179	B	417604	4667892	943	3
97	184	B	414540	4663749	994	3
98	197	B	424415	4659651	1075	3
99	187	B	424264	4661971	1075	2
100	198	B	427040	4662048	1075	3
101	199	B	426433	4660194	1075	3
102	200	B	424976	4662901	1075	3
103	192	B	425171	4657166	1075	2
104	193	B	425736	4658615	1075	2
105	194	B	425219	4661187	1075	2
106	185	B	426400	4661100	1075	2
107	186	B	425790	4661200	1075	2
108	223	B	427897	4667704	1099	3
109	224	B	425736	4658615	1099	3
110	225	B	424415	4659651	1099	3
111	226	B	426466	4665310	1099	3
112	228	B	425952	4654231	1099	3
113	227	B	425171	4657166	1099	3
114	232	B	424415	4659651	1100	4
115	231	B	425171	4657166	1100	3

Continue Table D

Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
116	233	B	430916	4662470	1100	4
117	243	B	426933	4664195	1150	3
118	245	B	426466	4665310	1150	3
119	247	B	424208	4655329	1150	3
120	248	B	424415	4659651	1150	3
121	249	B	417604	4667892	1150	3
122	250	B	427664	4663929	1150	3
123	237	B	425171	4657166	1150	2
124	238	B	426433	4660194	1150	2
125	239	B	427615	4663046	1150	2
126	240	B	424972	4660490	1150	2
127	253	B	426536	4666289	1150	3
128	254	B	422036	4667765	1150	3
129	242	B	427040	4662048	1150	3
130	252	B	430664	4656747	1150	3
131	283	B	422270	4666531	1198	3
132	276	B	427897	4667704	1198	3
133	290	B	423221	4666704	1198	4
134	267	B	424675	4669162	1198	2
135	277	B	422036	4667765	1198	3
136	278	B	432292	4665396	1198	3
137	279	B	429344	4664625	1198	3
138	269	B	431382	4659333	1198	2
139	270	B	430707	4664077	1198	2
140	284	B	418821	4670640	1198	3
141	271	B	433469	4664377	1198	2
142	286	B	428729	4666068	1198	3
143	288	B	422916	4669516	1198	3
144	294	B	423400	4670822	1198	4
145	272	B	428000	4672200	1198	3
146	289	B	424415	4659651	1198	4
147	320	B	424415	4659651	1225	4
148	302	B	417604	4667892	1225	3
149	301	B	426348	4663958	1225	3
150	298	B	422036	4667765	1225	2
151	300	B	432399	4664006	1225	3
152	325	B	423400	4670822	1225	4
153	296	B	424315	4664992	1225	2
154	311	B	425535	4663899	1225	3
155	304	B	414540	4663749	1225	3
156	336	B	424415	4659651	1355	4
157	330	B	426536	4666289	1355	3
158	331	B	426948	4669211	1355	3
159	334	B	427327	4662552	1355	3
160	335	B	418494	4661866	1355	3
161	333	B	427040	4662048	1355	3
162	327	B	418448	4639073	1355	2
163	328	B	419802	4639647	1355	2
164	329	B	412289	4665436	1355	2
165	337	B	430916	4662470	1355	4
166	332	B	430664	4656747	1355	3
167	350	B	423221	4666704	1357	4
168	343	B	422036	4667765	1357	3
169	342	B	407409	4672533	1357	3
170	341	B	419634	4664358	1357	3
171	347	B	419751	4658726	1357	3
172	348	B	423006	4647222	1357	3
173	345	B	427897	4667704	1357	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
174	349	B	431700	4655600	1357	3
175	351	B	407409	4672533	1421	3
176	352	B	431382	4659333	1432	2
177	354	B	432100	4655000	1432	3
178	357	B	423221	4666704	1443	4
179	355	B	422199	4656508	1443	2
180	358	B	414308	4673251	1443	4
181	356	B	424415	4659651	1443	4
182	360	B	432700	4656850	1462	2
183	363	B	431592	4656490	1462	3
184	362	B	414540	4663749	1462	3
185	361	B	431382	4659333	1462	3
186	364	B	428318	4661776	1462	3
187	359	B	425588	4661625	1462	2
188	369	B	426466	4665310	1462	3
189	370	B	422036	4667765	1462	3
190	373	B	416348	4658519	1462	3
191	375	B	424415	4659651	1462	4
192	390	B	427040	4662048	1471	3
193	395	B	428473	4663592	1471	3
194	394	B	426466	4665310	1471	3
195	384	B	424415	4659651	1471	2
196	392	B	428318	4661776	1471	3
197	382	B	422199	4656508	1471	2
198	402	B	424208	4655329	1471	3
199	385	B	412289	4665436	1471	2
200	398	B	426933	4664195	1471	3
201	387	B	429100	4662900	1471	3
202	391	B	414540	4663749	1471	3
203	424	B	424415	4659651	1562	3
204	428	B	414540	4663749	1562	3
205	435	B	423281	4664093	1562	3
206	436	B	425171	4657166	1562	3
207	426	B	422841	4664713	1562	3
208	423	B	424208	4655329	1562	3
209	427	B	426466	4665310	1562	3
210	438	B	428318	4661776	1562	3
211	429	B	426433	4660194	1562	3
212	441	B	425952	4654231	1562	3
213	431	B	427040	4662048	1562	3
214	450	B	417150	4668200	1591	3
215	451	B	420926	4651655	1591	3
216	452	B	411255	4663645	1591	3
217	453	B	425191	4646651	1730	3
218	455	B	427040	4662048	1730	3
219	456	B	424415	4659651	1730	4
220	460	B	426948	4669211	1759	3
221	464	B	414540	4663749	1759	3
222	459	B	424817	4669132	1759	3
223	461	B	431382	4659333	1759	3
224	458	B	424208	4655329	1759	3
225	466	B	425171	4657166	1759	3
226	467	B	426466	4665310	1759	3
227	468	B	426536	4666289	1759	3
228	471	B	424415	4659651	1759	4
229	479	B	422736	4665059	1812	2
230	486	B	424415	4659651	1812	3
231	496	B	422841	4664713	1812	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
232	487	B	428318	4661776	1812	3
233	478	B	427700	4661800	1812	2
234	488	B	426433	4660194	1812	3
235	491	B	423281	4664093	1812	3
236	498	B	414540	4663749	1812	3
237	482	B	425171	4657166	1812	2
238	483	B	433273	4639886	1812	2
239	480	B	422513	4660898	1812	2
240	481	B	412289	4665436	1812	2
241	510	B	423400	4670822	1812	4
242	485	B	427040	4662048	1812	3
243	518	B	429100	4654750	1819	3
244	516	B	424415	4659651	1819	3
245	522	B	425171	4657166	1819	3
246	523	B	423281	4664093	1819	3
247	525	B	417604	4667892	1819	3
248	513	B	422513	4660898	1819	2
249	514	B	412289	4665436	1819	2
250	515	B	414540	4663749	1819	2
251	544	B	423400	4670822	1819	4
252	531	B	425724	4656765	1819	3
253	529	B	428318	4661776	1819	3
254	530	B	426939	4656141	1819	3
255	549	B	424415	4659651	1838	3
256	550	B	426433	4660194	1838	3
257	551	B	426466	4665310	1838	3
258	548	B	425588	4661625	1838	2
259	552	B	428318	4661776	1838	3
260	568	B	432700	4656850	1851	3
261	574	B	431592	4656490	1851	3
262	571	B	414540	4663749	1851	3
263	563	B	428664	4668421	1851	3
264	579	B	423221	4666704	1851	4
265	566	B	426933	4664195	1851	3
266	569	B	428318	4661776	1851	3
267	564	B	414258	4661717	1851	3
268	562	B	427700	4661800	1851	2
269	572	B	426466	4665310	1851	3
270	573	B	422036	4667765	1851	3
271	575	B	423281	4664093	1851	3
272	576	B	424415	4659651	1851	4
273	565	B	430707	4664077	1851	3
274	560	B	429715	4668893	1851	2
275	585	B	426466	4665310	2049	3
276	593	B	424415	4659651	2049	4
277	584	B	426536	4666289	2049	3
278	587	B	423006	4647222	2049	3
279	589	B	427897	4667704	2049	3
280	590	B	424208	4655329	2049	3
281	591	B	426433	4660194	2049	3
282	592	B	427327	4662552	2049	3
283	588	B	425191	4646651	2049	3
284	586	B	424960	4653642	2049	3
285	598	B	416688	4656060	2374	3
286	599	B	416348	4658519	2374	3
287	600	B	417638	4658890	2394	3
288	602	B	424415	4659651	2394	4
289	604	B	407409	4672533	2496	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
290	607	B	417604	4667892	2518	3
291	605	B	430895	4655892	2518	3
292	608	B	424415	4659651	2518	4
293	606	B	426933	4664195	2518	3
294	609	B	417604	4667892	2542	3
295	612	B	427897	4667704	2660	3
296	615	B	426664	4664808	2660	3
297	614	B	427040	4662048	2660	3
298	611	B	426348	4663958	2660	2
299	620	B	419634	4664358	2660	3
300	621	B	427327	4662552	2660	3
301	622	B	430916	4662470	2660	4
302	619	B	425952	4654231	2660	3
303	617	B	425171	4657166	2660	3
304	618	B	430664	4656747	2660	3
305	623	B	424415	4659651	2660	4
306	624	B	425219	4661187	2808	2
307	625	B	424415	4659651	2808	4
308	628	B	424296	4650546	2845	3
309	627	B	414540	4663749	2845	3
310	629	B	427897	4667704	2845	3
311	630	B	424208	4655329	2845	3
312	632	B	424415	4659651	2845	4
313	631	B	430664	4656747	2845	3
314	626	B	426704	4650338	2845	3
315	640	B	423558	4655856	2913	2
316	643	B	424208	4655329	2913	3
317	644	B	424415	4659651	2913	4
318	641	B	424271	4641400	2913	2
319	642	B	423161	4656401	2913	2
320	647	B	430964	4643698	3037	3
321	646	B	426624	4645651	3037	2
322	648	B	414540	4663749	3037	3
323	657	B	427040	4662048	3187	3
324	655	B	424415	4659651	3187	3
325	656	B	425544	4655026	3187	3
326	658	B	427615	4663046	3187	3
327	652	B	425171	4657166	3187	2
328	653	B	426433	4660194	3187	2
329	654	B	426085	4659104	3187	2
330	673	B	424264	4661971	3187	3
331	649	B	426400	4661100	3187	2
332	650	B	425790	4661200	3187	2
333	660	B	428318	4661776	3187	3
334	670	B	425724	4656765	3187	3
335	666	B	426939	4656141	3187	3
336	704	B	419193	4637944	3206	3
337	694	B	414540	4663749	3206	3
338	719	B	423221	4666704	3206	4
339	693	B	427040	4662048	3206	3
340	703	B	422841	4664713	3206	3
341	690	B	407409	4672533	3206	3
342	691	B	414258	4661717	3206	3
343	692	B	424117	4640362	3206	3
344	695	B	424415	4659651	3206	3
345	696	B	427897	4667704	3206	3
346	698	B	425171	4657166	3206	3
347	699	B	428318	4661776	3206	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
348	700	B	422036	4667765	3206	3
349	701	B	424960	4653642	3206	3
350	702	B	426466	4665310	3206	3
351	688	B	426348	4663958	3206	2
352	712	B	419634	4664358	3206	3
353	713	B	427327	4662552	3206	3
354	721	B	423400	4670822	3206	4
355	718	B	430916	4662470	3206	4
356	709	B	425952	4654231	3206	3
357	710	B	425724	4656765	3206	3
358	706	B	426939	4656141	3206	3
359	708	B	430664	4656747	3206	3
360	724	B	427897	4667704	3207	3
361	725	B	422036	4667765	3207	3
362	726	B	426116	4671315	3207	3
363	723	B	411255	4663645	3207	2
364	727	B	428473	4663592	3420	2
365	745	B	424415	4659651	3420	4
366	728	B	431382	4659333	3420	3
367	737	B	428318	4661776	3420	3
368	738	B	427040	4662048	3420	3
369	740	B	426536	4666289	3420	3
370	733	B	422036	4667765	3420	3
371	735	B	426466	4665310	3420	3
372	744	B	414540	4663749	3420	3
373	754	B	423221	4666704	3420	4
374	757	B	424315	4664992	3443	2
375	759	B	432002	4646482	3443	3
376	764	B	414540	4663749	3443	3
377	760	B	422036	4667765	3443	3
378	763	B	420926	4651655	3443	3
379	758	B	428000	4672200	3443	3
380	765	B	424415	4659651	3443	4
381	774	B	428473	4663592	3471	2
382	776	B	426466	4665310	3471	3
383	777	B	422841	4664713	3471	3
384	778	B	424415	4659651	3471	3
385	775	B	425171	4657166	3471	3
386	773	B	422736	4665059	3471	2
387	792	B	417604	4667892	3471	3
388	793	B	426433	4660194	3471	3
389	787	B	428318	4661776	3471	3
390	786	B	427040	4662048	3471	3
391	807	B	417604	4667892	3551	3
392	809	B	432700	4656850	3597	2
393	821	B	431592	4656490	3597	3
394	810	B	426466	4665310	3597	3
395	813	B	414540	4663749	3597	3
396	808	B	424296	4650546	3597	2
397	817	B	422036	4667765	3597	3
398	819	B	428238	4664983	3597	3
399	826	B	419634	4664358	3597	3
400	822	B	425724	4656765	3597	3
401	823	B	426416	4651417	3597	3
402	825	B	424960	4653642	3597	3
403	811	B	429100	4662900	3597	3
404	828	B	424415	4659651	3597	4
405	833	B	424315	4664992	3604	2

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
406	847	B	429604	4663900	3604	3
407	848	B	425634	4663439	3604	3
408	839	B	429100	4654750	3604	3
409	834	B	422036	4667765	3604	3
410	836	B	414540	4663749	3604	3
411	837	B	426466	4665310	3604	3
412	849	B	418494	4661866	3604	3
413	851	B	417604	4667892	3604	3
414	855	B	430916	4662470	3604	4
415	853	B	424415	4659651	3604	4
416	844	B	429003	4655166	3604	3
417	866	B	428664	4668421	3659	3
418	867	B	414540	4663749	3659	3
419	863	B	417150	4668200	3659	3
420	877	B	424415	4659651	3659	4
421	864	B	425191	4646651	3659	3
422	865	B	422036	4667765	3659	3
423	862	B	431592	4656490	3659	2
424	869	B	424208	4655329	3659	3
425	870	B	429003	4655166	3659	3
426	871	B	431382	4659333	3659	3
427	874	B	425724	4656765	3659	3
428	875	B	430916	4662470	3659	4
429	885	B	427040	4662048	3796	3
430	883	B	424415	4659651	3796	3
431	884	B	425544	4655026	3796	3
432	888	B	427615	4663046	3796	3
433	896	B	426433	4660194	3796	3
434	897	B	424208	4655329	3796	3
435	898	B	422841	4664713	3796	3
436	899	B	425171	4657166	3796	3
437	879	B	426400	4661100	3796	2
438	880	B	425790	4661200	3796	2
439	892	B	428318	4661776	3796	3
440	903	B	425724	4656765	3796	3
441	902	B	426939	4656141	3796	3
442	916	B	422036	4667765	3801	3
443	919	B	427664	4663929	3801	3
444	921	B	423281	4664093	3801	3
445	918	B	428318	4661776	3801	3
446	912	B	422646	4663836	3801	2
447	913	B	427615	4663046	3801	2
448	914	B	431013	4662033	3801	2
449	939	B	423400	4670822	3801	4
450	925	B	426933	4664195	3801	3
451	935	B	424415	4659651	3801	4
452	917	B	427040	4662048	3801	3
453	924	B	426664	4664808	3801	3
454	944	B	414540	4663749	3832	3
455	945	B	424415	4659651	3832	3
456	956	B	427040	4662048	3844	3
457	961	B	422841	4664713	3844	3
458	954	B	407409	4672533	3844	3
459	955	B	424117	4640362	3844	3
460	957	B	424415	4659651	3844	3
461	958	B	428318	4661776	3844	3
462	959	B	426536	4666289	3844	3
463	960	B	427897	4667704	3844	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
464	949	B	426348	4663958	3844	2
465	966	B	419634	4664358	3844	3
466	963	B	426664	4664808	3844	3
467	947	B	426400	4661100	3844	2
468	948	B	425790	4661200	3844	2
469	968	B	430916	4662470	3844	4
470	973	B	422036	4667765	3846	3
471	974	B	424415	4659651	3846	4
472	977	B	414540	4663749	4049	3
473	980	B	417604	4667892	4049	3
474	985	B	424415	4659651	4049	4
475	982	B	427615	4663046	4049	3
476	983	B	426433	4660194	4049	3
477	984	B	427897	4667704	4049	3
478	995	B	424415	4659651	4103	4
479	994	B	426933	4664195	4103	3
480	989	B	426536	4666289	4103	3
481	990	B	426664	4664808	4103	3
482	991	B	426948	4669211	4103	3
483	988	B	428473	4663592	4103	2
484	992	B	426466	4665310	4103	3
485	993	B	422270	4666531	4103	3
486	999	B	426466	4665310	4138	3
487	1000	B	420926	4651655	4138	3
488	1002	B	425191	4646651	4138	3
489	1003	B	426948	4669211	4138	3
490	1006	B	427327	4668449	4138	3
491	1007	B	417604	4667892	4138	4
492	1011	B	422199	4656508	4162	2
493	1031	B	426933	4664195	4162	3
494	1022	B	426466	4665310	4162	3
495	1023	B	423281	4664093	4162	3
496	1026	B	426433	4660194	4162	3
497	1027	B	424415	4659651	4162	3
498	1028	B	425171	4657166	4162	3
499	1037	B	425724	4656765	4162	3
500	1038	B	424264	4661971	4162	3
501	1052	B	423400	4670822	4162	4
502	1009	B	426400	4661100	4162	2
503	1010	B	425790	4661200	4162	2
504	1020	B	427040	4662048	4162	3
505	1021	B	428318	4661776	4162	3
506	1039	B	425952	4654231	4162	3
507	1034	B	426939	4656141	4162	3
508	1055	B	417150	4668200	4268	3
509	1054	B	407409	4672533	4268	3
510	1056	B	417604	4667892	4268	3
511	1057	B	410970	4660333	4268	3
512	1059	B	419519	4644869	4309	2
513	1065	B	424415	4659651	4364	3
514	1066	B	428318	4661776	4364	3
515	1061	B	425790	4661200	4364	2
516	1063	B	422317	4644077	4364	3
517	1064	B	427040	4662048	4364	3
518	1070	B	425952	4654231	4364	3
519	1071	B	425724	4656765	4364	3
520	1068	B	426939	4656141	4364	3
521	1069	B	425171	4657166	4364	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
522	1086	B	423281	4664093	4383	3
523	1087	B	414540	4663749	4383	3
524	1078	B	422841	4664713	4383	3
525	1089	B	426433	4660194	4383	3
526	1075	B	424208	4655329	4383	3
527	1079	B	427897	4667704	4383	3
528	1076	B	414258	4661717	4383	3
529	1082	B	424415	4659651	4383	3
530	1084	B	426466	4665310	4383	3
531	1090	B	427040	4662048	4383	3
532	1077	B	428000	4672200	4383	3
533	1080	B	422317	4644077	4383	3
534	1081	B	421126	4660838	4383	3
535	1103	B	414540	4663749	4386	3
536	1107	B	424415	4659651	4386	4
537	1106	B	416688	4656060	4386	3
538	1104	B	427897	4667704	4386	3
539	1105	B	417604	4667892	4386	3
540	1112	B	414540	4663749	4415	3
541	1113	B	407409	4672533	4415	3
542	1118	B	427897	4667704	4415	3
543	1111	B	427327	4668449	4415	2
544	1120	B	417638	4658890	4415	3
545	1121	B	416381	4661495	4415	3
546	1119	B	416962	4660924	4415	3
547	1122	B	424415	4659651	4415	4
548	1116	B	414231	4664166	4415	3
549	1132	B	416688	4656060	4464	3
550	1125	B	414540	4663749	4464	3
551	1126	B	407409	4672533	4464	3
552	1128	B	417604	4667892	4464	3
553	1129	B	421433	4655749	4464	3
554	1133	B	414308	4673251	4464	4
555	1134	B	424415	4659651	4464	4
556	1135	B	407409	4672533	4508	3
557	1149	B	417213	4643692	4516	3
558	1136	B	428473	4663592	4516	3
559	1139	B	414540	4663749	4516	3
560	1150	B	424415	4659651	4516	4
561	1142	B	427897	4667704	4516	3
562	1143	B	426536	4666289	4516	3
563	1144	B	417604	4667892	4516	3
564	1148	B	427327	4662552	4516	3
565	1140	B	426433	4660194	4516	3
566	1137	B	428000	4672200	4516	3
567	1146	B	426664	4664808	4516	3
568	1154	B	414540	4663749	4581	3
569	1161	B	418797	4667462	4581	3
570	1157	B	417200	4667800	4581	3
571	1160	B	417604	4667892	4581	3
572	1156	B	428000	4672200	4581	3
573	1162	B	410970	4660333	4581	3
574	1163	B	407409	4672533	4581	3
575	1164	B	414308	4673251	4581	3
576	1165	B	432143	4664894	4581	3
577	1158	B	424225	4664561	4581	3
578	1166	B	419634	4664358	4676	3
579	1167	B	424415	4659651	4754	4

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
580	1170	B	424415	4659651	4763	4
581	1169	B	422036	4667765	4763	3
582	1181	B	424415	4659651	4815	4
583	1175	B	422841	4664713	4815	3
584	1173	B	407409	4672533	4815	3
585	1176	B	420926	4651655	4815	3
586	1177	B	417604	4667892	4815	3
587	1178	B	426116	4671315	4815	3
588	1180	B	427040	4662048	4815	3
589	1174	B	428000	4672200	4815	3
590	1172	B	419802	4639647	4815	2
591	1182	B	430916	4662470	4815	4
592	1179	B	430895	4655892	4815	3
593	1185	B	427897	4667704	4839	2
594	1186	B	414540	4663749	4839	2
595	1213	B	424817	4669132	4839	3
596	1192	B	429003	4655166	4839	3
597	1194	B	422036	4667765	4839	3
598	1195	B	426466	4665310	4839	3
599	1184	B	422199	4656508	4839	2
600	1205	B	424415	4659651	4839	3
601	1207	B	424296	4650546	4839	3
602	1220	B	423221	4666704	4839	4
603	1225	B	426664	4664808	4839	4
604	1187	B	424208	4655329	4839	3
605	1193	B	426933	4664195	4839	3
606	1202	B	426536	4666289	4839	3
607	1204	B	425191	4646651	4839	3
608	1211	B	419634	4664358	4839	3
609	1214	B	418494	4661866	4839	3
610	1189	B	428000	4672200	4839	3
611	1223	B	423400	4670822	4839	4
612	1227	B	414540	4663749	4841	3
613	1246	B	423221	4666704	4859	4
614	1232	B	432568	4645352	4859	3
615	1236	B	414540	4663749	4859	3
616	1231	B	407409	4672533	4859	3
617	1244	B	424415	4659651	4859	4
618	1238	B	426116	4671315	4859	3
619	1239	B	426536	4666289	4859	3
620	1240	B	417604	4667892	4859	3
621	1233	B	428000	4672200	4859	3
622	1229	B	419193	4637944	4859	2
623	1230	B	419802	4639647	4859	2
624	1242	B	420446	4637887	4859	3
625	1243	B	430916	4662470	4859	4
626	1241	B	429003	4655166	4859	3
627	1234	B	432002	4646482	4859	3
628	1247	B	424817	4669132	4931	3
629	1249	B	429344	4664625	4931	3
630	1250	B	422036	4667765	4931	3
631	1251	B	431382	4659333	4931	3
632	1252	B	414308	4673251	4931	3
633	1248	B	428000	4672200	4931	3
634	1254	B	431382	4659333	4998	3
635	1255	B	414540	4663749	4998	3
636	1256	B	424415	4659651	4998	3
637	1260	B	425171	4657166	4998	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
638	1261	B	426085	4659104	4998	3
639	1262	B	417604	4667892	4998	3
640	1274	B	423400	4670822	4998	4
641	1271	B	430916	4662470	4998	4
642	1266	B	425952	4654231	4998	3
643	1267	B	425724	4656765	4998	3
644	1265	B	426939	4656141	4998	3
645	1280	B	414540	4663749	5001	3
646	1278	B	426151	4665250	5001	2
647	1279	B	425191	4646651	5001	3
648	1285	B	426048	4668292	5001	3
649	1281	B	426433	4660194	5001	3
650	1283	B	427897	4667704	5001	3
651	1284	B	422036	4667765	5001	3
652	1286	B	430916	4662470	5001	4
653	1287	B	424415	4659651	5001	4
654	1288	B	414540	4663749	5046	3
655	1330	B	424817	4669132	5088	3
656	1327	B	423748	4664000	5088	3
657	1291	B	428473	4663592	5088	2
658	1300	B	431382	4659333	5088	3
659	1325	B	422036	4667765	5088	3
660	1326	B	427040	4662048	5088	3
661	1316	B	424146	4667427	5088	3
662	1296	B	430456	4659155	5088	2
663	1297	B	426433	4660194	5088	2
664	1298	B	427369	4658985	5088	2
665	1299	B	431324	4669673	5088	2
666	1334	B	422916	4669516	5088	3
667	1290	B	429902	4658401	5088	2
668	1339	B	423221	4666704	5088	4
669	1335	B	424415	4659651	5088	4
670	1302	B	430707	4664077	5088	3
671	1310	B	429100	4662900	5088	3
672	1294	B	427327	4662552	5088	2
673	1342	B	420926	4651655	5249	3
674	1343	B	419751	4658726	5249	3
675	1345	B	427040	4662048	5249	3
676	1344	B	430895	4655892	5249	3
677	1346	B	424415	4659651	5256	4
678	1347	B	424296	4650546	5265	3
679	1348	B	430916	4662470	5265	4
680	1354	B	431382	4659333	5321	3
681	1350	B	432300	4654900	5321	2
682	1363	B	431592	4656490	5321	3
683	1366	B	429003	4655166	5321	3
684	1351	B	422036	4667765	5321	3
685	1356	B	417150	4668200	5321	3
686	1352	B	407409	4672533	5321	3
687	1349	B	433500	4660100	5321	2
688	1377	B	415675	4669234	5321	4
689	1380	B	414308	4673251	5321	4
690	1355	B	428000	4672200	5321	3
691	1383	B	412923	4663051	5321	4
692	1382	B	423400	4670822	5321	4
693	1373	B	424415	4659651	5321	4
694	1390	B	427350	4664773	5321	4
695	1353	B	429100	4662900	5321	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
696	1358	B	414540	4663749	5321	3
697	1391	B	422036	4667765	5336	3
698	1392	B	424415	4659651	5336	4
699	1393	B	431382	4659333	5339	3
700	1394	B	427897	4667704	5339	3
701	1395	B	424415	4659651	5354	4
702	1399	B	425000	4660300	5448	3
703	1400	B	426433	4660194	5448	3
704	1401	B	425171	4657166	5448	3
705	1398	B	426348	4663958	5448	2
706	1402	B	424415	4659651	5448	4
707	1403	B	417604	4667892	5603	3
708	1405	B	414540	4663749	5609	3
709	1404	B	408387	4669799	5609	2
710	1407	B	424960	4653642	5609	3
711	1416	B	414540	4663749	5611	3
712	1417	B	428664	4668421	5611	3
713	1413	B	426466	4665310	5611	3
714	1415	B	422841	4664713	5611	3
715	1422	B	424415	4659651	5611	4
716	1428	B	423221	4666704	5611	4
717	1411	B	424315	4664992	5611	2
718	1419	B	423281	4664093	5611	3
719	1420	B	426433	4660194	5611	3
720	1421	B	426536	4666289	5611	3
721	1412	B	422364	4661408	5611	2
722	1440	B	426466	4665310	5633	3
723	1438	B	424415	4659651	5633	3
724	1449	B	414540	4663749	5633	3
725	1439	B	425544	4655026	5633	3
726	1451	B	428318	4661776	5633	3
727	1452	B	425171	4657166	5633	3
728	1434	B	426933	4664195	5633	2
729	1459	B	426536	4666289	5633	3
730	1432	B	426400	4661100	5633	2
731	1433	B	425790	4661200	5633	2
732	1461	B	425952	4654231	5633	3
733	1462	B	425724	4656765	5633	3
734	1456	B	426939	4656141	5633	3
735	1445	B	427040	4662048	5633	3
736	1486	B	424415	4659651	5634	4
737	1476	B	414540	4663749	5634	3
738	1482	B	429604	4663900	5634	3
739	1483	B	422841	4664713	5634	3
740	1479	B	423281	4664093	5634	3
741	1480	B	424208	4655329	5634	3
742	1475	B	416971	4660522	5634	2
743	1495	B	414540	4663749	5662	3
744	1496	B	424415	4659651	5662	4
745	1494	B	431382	4659333	5662	3
746	1519	B	422036	4667765	5674	3
747	1520	B	424817	4669132	5674	3
748	1521	B	429604	4663900	5674	3
749	1510	B	431382	4659333	5674	3
750	1509	B	414540	4663749	5674	3
751	1524	B	423221	4666704	5674	3
752	1506	B	427040	4662048	5674	3
753	1503	B	428473	4663592	5674	2

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
754	1504	B	424315	4664992	5674	2
755	1513	B	427897	4667704	5674	3
756	1514	B	424208	4655329	5674	3
757	1518	B	427327	4662552	5674	3
758	1517	B	425724	4656765	5674	3
759	1525	B	424415	4659651	5674	4
760	1541	B	424415	4659651	5684	4
761	1536	B	424296	4650546	5684	2
762	1539	B	426536	4666289	5684	3
763	1537	B	426348	4663958	5684	2
764	1540	B	419634	4664358	5684	3
765	1538	B	430002	4638082	5684	3
766	1557	B	417213	4643692	5769	3
767	1549	B	431382	4659333	5769	3
768	1554	B	414540	4663749	5769	3
769	1558	B	424415	4659651	5769	4
770	1548	B	429344	4664625	5769	3
771	1551	B	422036	4667765	5769	3
772	1552	B	427897	4667704	5769	3
773	1547	B	419519	4644869	5769	2
774	1564	B	429003	4655166	5812	3
775	1565	B	424415	4659651	5812	4
776	1566	B	420926	4651655	5825	3
777	1568	B	414308	4673251	5850	3
778	1567	B	428000	4672200	5850	3
779	1580	B	424415	4659651	5870	4
780	1569	B	427897	4667704	5870	3
781	1576	B	422841	4664713	5870	3
782	1575	B	423281	4664093	5870	3
783	1570	B	414540	4663749	5870	3
784	1589	B	420021	4643438	5874	4
785	1585	B	424415	4659651	5874	4
786	1583	B	427897	4667704	5874	3
787	1593	B	414540	4663749	5892	3
788	1596	B	424415	4659651	5892	4
789	1592	B	419610	4666891	5892	3
790	1594	B	422036	4667765	5892	3
791	1595	B	424208	4655329	5892	3
792	1604	B	416688	4656060	5919	3
793	1609	B	424415	4659651	5919	4
794	1603	B	407409	4672533	5919	3
795	1602	B	424208	4655329	5919	3
796	1605	B	427897	4667704	5919	3
797	1606	B	419634	4664358	5919	3
798	1607	B	419751	4658726	5919	3
799	1608	B	431324	4669673	5919	3
800	1611	B	430916	4662470	5919	4
801	1600	B	419519	4644869	5919	2
802	1614	B	431382	4659333	5970	3
803	1624	B	424296	4650546	5970	3
804	1618	B	417150	4668200	5970	3
805	1629	B	424415	4659651	5970	4
806	1621	B	426116	4671315	5970	3
807	1622	B	417604	4667892	5970	3
808	1613	B	407409	4672533	5970	2
809	1632	B	414308	4673251	5970	4
810	1616	B	428000	4672200	5970	3
811	1631	B	430916	4662470	5970	4

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
812	1634	B	414540	4663749	5970	4
813	1626	B	424675	4669162	5970	3
814	1635	B	428000	4672200	6049	3
815	1636	B	417150	4668200	6074	3
816	1637	B	417604	4667892	6074	3
817	1639	B	418494	4661866	6074	3
818	1640	B	424208	4655329	6075	3
819	1641	B	425116	4642550	6075	3
820	1642	B	425191	4646651	6075	3
821	1643	B	407224	4670196	6075	3
822	1644	B	424415	4659651	6075	4
823	1646	B	424415	4659651	6076	4
824	1645	B	422000	4666000	6076	2
825	1665	B	428664	4668421	6078	3
826	1691	B	414540	4663749	6078	4
827	1657	B	427897	4667704	6078	3
828	1658	B	426151	4665250	6078	3
829	1664	B	429344	4664625	6078	3
830	1650	B	424598	4647335	6078	2
831	1651	B	428473	4663592	6078	2
832	1677	B	429003	4655166	6078	3
833	1679	B	426466	4665310	6078	3
834	1652	B	422036	4667765	6078	2
835	1654	B	426624	4645651	6078	2
836	1655	B	429962	4653054	6078	2
837	1656	B	431382	4659333	6078	2
838	1683	B	426536	4666289	6078	3
839	1671	B	419634	4664358	6078	3
840	1663	B	434595	4642478	6078	3
841	1669	B	434698	4643238	6078	3
842	1649	B	430002	4638082	6078	2
843	1672	B	423257	4651128	6078	3
844	1686	B	430916	4662470	6078	4
845	1653	B	422364	4661408	6078	2
846	1670	B	426933	4664195	6078	3
847	1685	B	424415	4659651	6078	4
848	1682	B	431700	4655600	6078	3
849	1697	B	424415	4659651	6102	4
850	1695	B	414540	4663749	6102	3
851	1703	B	420926	4651655	6146	3
852	1704	B	425191	4646651	6146	3
853	1707	B	426466	4665310	6218	3
854	1705	B	430895	4655892	6218	2
855	1708	B	426933	4664195	6218	3
856	1709	B	414540	4663749	6218	3
857	1706	B	427040	4662048	6218	3
858	1714	B	426416	4651417	6218	3
859	1717	B	424415	4659651	6218	4
860	1712	B	430664	4656747	6218	3
861	1737	B	427040	4662048	6224	3
862	1735	B	424415	4659651	6224	3
863	1736	B	425171	4657166	6224	3
864	1728	B	426400	4661100	6224	2
865	1729	B	425790	4661200	6224	2
866	1739	B	428318	4661776	6224	3
867	1730	B	422364	4661408	6224	2
868	1744	B	425724	4656765	6224	3
869	1742	B	426939	4656141	6224	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
870	1757	B	426664	4664808	6240	3
871	1759	B	422706	4656689	6260	4
872	1758	B	424415	4659651	6260	4
873	1763	B	424415	4659651	6561	4
874	1764	B	424415	4659651	6568	4
875	1766	B	424415	4659651	6659	4
876	1765	B	414540	4663749	6659	3
877	1772	B	414540	4663749	6762	3
878	1770	B	419751	4658726	6762	2
879	1778	B	423281	4664093	6762	3
880	1781	B	424415	4659651	6762	4
881	1774	B	432002	4646482	6762	3
882	1783	B	428000	4672200	6842	3
883	1784	B	414540	4663749	6933	3
884	1785	B	425191	4646651	7029	3
885	1786	B	426348	4663958	7138	2
886	1787	B	419634	4664358	7138	3
887	1797	B	427327	4668449	7257	3
888	1800	B	428318	4661776	7257	3
889	1788	B	426536	4666289	7257	2
890	1813	B	423400	4670822	7257	4
891	1793	B	426433	4660194	7257	2
892	1794	B	425544	4655026	7257	2
893	1795	B	427040	4662048	7257	2
894	1796	B	427897	4667704	7257	2
895	1807	B	424415	4659651	7257	4
896	1804	B	425952	4654231	7257	3
897	1801	B	425171	4657166	7257	3
898	1802	B	426939	4656141	7257	3
899	1819	B	424415	4659651	7291	4
900	1815	B	432700	4656850	7291	3
901	1816	B	422036	4667765	7291	3
902	1817	B	427897	4667704	7291	3
903	1818	B	426116	4671315	7291	3
904	1827	B	431382	4659333	7334	3
905	1833	B	414540	4663749	7334	3
906	1826	B	407409	4672533	7334	3
907	1829	B	427897	4667704	7334	3
908	1834	B	426536	4666289	7334	3
909	1836	B	424208	4655329	7334	3
910	1824	B	424194	4651835	7334	2
911	1828	B	428000	4672200	7334	3
912	1823	B	426933	4664195	7334	2
913	1825	B	419193	4637944	7334	2
914	1839	B	424960	4653642	7334	3
915	1840	B	419802	4639647	7334	3
916	1842	B	430916	4662470	7334	4
917	1837	B	429003	4655166	7334	3
918	1830	B	422036	4667765	7334	3
919	1831	B	424415	4659651	7334	3
920	1838	B	430664	4656747	7334	3
921	1843	B	423221	4666704	7334	4
922	1848	B	427327	4668449	7522	3
923	1845	B	424296	4650546	7522	2
924	1850	B	427897	4667704	7522	3
925	1851	B	422036	4667765	7522	3
926	1846	B	426933	4664195	7522	2
927	1853	B	424960	4653642	7522	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
928	1854	B	426416	4651417	7522	3
929	1856	B	426664	4664808	7522	3
930	1857	B	426536	4666289	7522	3
931	1859	B	423281	4664093	7522	3
932	1861	B	430916	4662470	7522	4
933	1860	B	424415	4659651	7522	4
934	1858	B	425952	4654231	7522	3
935	1852	B	425171	4657166	7522	3
936	1863	B	422036	4667765	7569	3
937	1865	B	412923	4663051	7569	4
938	1864	B	424415	4659651	7569	4
939	1867	B	414540	4663749	7723	3
940	1868	B	407409	4672533	7723	3
941	1871	B	429003	4655166	7723	3
942	1874	B	424415	4659651	7723	4
943	1866	B	419193	4637944	7723	2
944	1872	B	410970	4660333	7723	3
945	1873	B	419802	4639647	7723	3
946	1875	B	435001	4663044	8109	3
947	1877	B	435001	4663044	8112	3
948	1879	B	419969	4661591	8124	3
949	1881	B	420926	4651655	8134	3
950	1880	B	419969	4661591	8134	3
951	1889	B	415675	4669234	8140	4
952	1882	B	414308	4673251	8140	3
953	1884	B	407409	4672533	8140	3
954	1885	B	422036	4667765	8140	3
955	1883	B	426933	4672756	8140	3
956	1891	B	425957	4641175	8235	3
957	1893	B	414540	4663749	8270	3
958	1892	B	424415	4659651	8270	3
959	1895	B	426536	4666289	8270	3
960	1896	B	424208	4655329	8270	3
961	1897	B	427040	4662048	8270	3
962	1900	B	427327	4662552	8270	3
963	1901	B	418086	4642318	8270	3
964	1899	B	425952	4654231	8270	3
965	1898	B	425171	4657166	8270	3
966	518	H	407409	4672533	6049	3
967	641	H	407409	4672533	8140	3
968	96	H	412005	4660257	1357	2
969	487	H	412005	4660257	5970	2
970	514	H	413689	4671924	6049	3
971	362	H	414308	4673251	4931	3
972	318	H	414308	4673251	4581	3
973	93	H	414474	4675667	1357	2
974	121	H	414540	4663749	1462	3
975	206	H	414540	4663749	3597	3
976	260	H	414540	4663749	4049	3
977	307	H	414540	4663749	4415	3
978	315	H	414540	4663749	4516	3
979	346	H	414540	4663749	4859	3
980	606	H	416348	4658519	7291	3
981	511	H	416688	4656060	6049	3
982	542	H	416688	4656060	6078	3
983	344	H	417604	4667892	4859	3
984	403	H	417604	4667892	5321	3
985	252	H	417604	4667892	3844	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
986	378	H	417604	4667892	5249	3
987	460	H	417604	4667892	5870	3
988	519	H	418494	4661866	6074	3
989	193	H	418821	4670640	3420	3
990	400	H	418821	4670640	5321	3
991	452	H	418821	4670640	5769	3
992	503	H	418821	4670640	5970	3
993	577	H	418821	4670640	6078	3
994	515	H	418958	4664110	6049	2
995	525	H	418958	4664110	6074	2
996	27	H	419036	4656384	674	3
997	92	H	419036	4656384	1357	1
998	223	H	419036	4656384	3659	1
999	280	H	419036	4656384	4268	1
1000	468	H	419036	4656384	5970	1
1001	626	H	419036	4656384	7723	1
1002	117	H	419193	4637944	1462	2
1003	91	H	419367	4656138	1357	1
1004	21	H	419540	4651209	674	3
1005	167	H	419540	4651209	2374	3
1006	289	H	419540	4651209	4268	3
1007	498	H	419540	4651209	5970	3
1008	598	H	419540	4651209	6842	3
1009	630	H	419540	4651209	7723	3
1010	175	H	419775	4644504	2913	3
1011	466	H	419857	4651034	5970	1
1012	292	H	420563	4654519	4309	1
1013	95	H	421091	4671084	1357	3
1014	230	H	421091	4671084	3659	3
1015	147	H	421652	4665587	1812	3
1016	161	H	421652	4665587	2049	3
1017	200	H	421652	4665587	3471	3
1018	413	H	421652	4665587	5611	3
1019	589	H	421652	4665587	6224	3
1020	419	H	422036	4667765	5611	3
1021	575	H	422036	4667765	6078	3
1022	191	H	422036	4667765	3420	3
1023	195	H	422036	4667765	3443	3
1024	236	H	422036	4667765	3659	3
1025	326	H	422036	4667765	4815	3
1026	345	H	422036	4667765	4859	3
1027	444	H	422036	4667765	5674	3
1028	461	H	422036	4667765	5870	3
1029	502	H	422036	4667765	5970	3
1030	51	H	422036	4667765	836	3
1031	216	H	422036	4667765	3604	3
1032	303	H	422036	4667765	4386	3
1033	332	H	422036	4667765	4839	3
1034	399	H	422036	4667765	5321	3
1035	169	H	422169	4660738	2394	3
1036	162	H	422317	4644077	2049	3
1037	62	H	422739	4661884	994	3
1038	168	H	422739	4661884	2394	3
1039	173	H	422739	4661884	2660	3
1040	186	H	422739	4661884	3206	3
1041	215	H	422739	4661884	3604	3
1042	265	H	422739	4661884	4103	3
1043	297	H	422739	4661884	4364	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1044	305	H	422739	4661884	4415	3
1045	311	H	422739	4661884	4516	3
1046	617	H	422739	4661884	7522	3
1047	123	H	423558	4655856	1471	3
1048	545	H	423558	4655856	6078	3
1049	347	H	423656	4647784	4931	1
1050	176	H	424038	4642406	3037	2
1051	75	H	424146	4667427	1198	3
1052	226	H	424146	4667427	3659	3
1053	267	H	424296	4650546	4103	2
1054	571	H	424296	4650546	6078	3
1055	228	H	424296	4650546	3659	2
1056	120	H	424415	4659651	1462	3
1057	125	H	424415	4659651	1471	3
1058	137	H	424415	4659651	1730	3
1059	140	H	424415	4659651	1759	3
1060	143	H	424415	4659651	1812	3
1061	151	H	424415	4659651	1819	3
1062	198	H	424415	4659651	3443	3
1063	250	H	424415	4659651	3844	3
1064	306	H	424415	4659651	4415	3
1065	319	H	424415	4659651	4762	3
1066	340	H	424415	4659651	4839	3
1067	407	H	424415	4659651	5609	3
1068	430	H	424415	4659651	5633	3
1069	431	H	424415	4659651	5634	3
1070	445	H	424415	4659651	5674	3
1071	505	H	424415	4659651	5970	3
1072	241	H	424415	4659651	3796	3
1073	603	H	424415	4659651	7257	4
1074	365	H	424550	4648848	4998	1
1075	437	H	424550	4648848	5674	1
1076	614	H	424550	4648848	7522	1
1077	83	H	424550	4648848	1355	1
1078	453	H	424554	4667596	5812	1
1079	457	H	424554	4667596	5850	3
1080	643	H	424554	4667596	8270	3
1081	322	H	424691	4677146	4815	1
1082	254	H	424944	4641734	4049	1
1083	271	H	424985	4647770	4162	1
1084	334	H	424985	4647770	4839	2
1085	343	H	424985	4647770	4859	2
1086	364	H	424985	4647770	4998	1
1087	392	H	424985	4647770	5265	2
1088	642	H	424985	4647770	8270	2
1089	7	H	424985	4647770	628	1
1090	81	H	424985	4647770	1355	1
1091	135	H	424985	4647770	1730	1
1092	149	H	424985	4647770	1819	1
1093	220	H	425288	4644299	3659	1
1094	436	H	425288	4644299	5674	1
1095	529	H	425288	4644299	6078	1
1096	465	H	425373	4641740	5970	1
1098	8	H	425535	4663899	628	3
1099	43	H	425585	4641981	836	1
1100	63	H	425645	4663317	1100	4
1101	122	H	425645	4663317	1471	2
1102	128	H	425645	4663317	1562	4

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1103	174	H	425645	4663317	2845	4
1104	177	H	425645	4663317	3187	4
1105	239	H	425645	4663317	3796	4
1106	244	H	425645	4663317	3801	4
1107	304	H	425645	4663317	4386	4
1108	313	H	425645	4663317	4516	4
1109	325	H	425645	4663317	4815	4
1110	327	H	425645	4663317	4839	4
1111	404	H	425645	4663317	5321	4
1112	421	H	425645	4663317	5633	4
1113	501	H	425645	4663317	5970	4
1114	15	H	426016	4641428	674	1
1115	179	H	426029	4642786	3206	1
1116	594	H	426029	4642786	6833	1
1117	32	H	426200	4659500	682	2
1118	422	H	426200	4659500	5633	2
1119	139	H	426466	4665310	1759	3
1120	159	H	426466	4665310	1851	3
1121	204	H	426466	4665310	3471	3
1122	205	H	426466	4665310	3597	3
1123	13	H	426466	4665310	628	3
1124	86	H	426512	4663671	1355	3
1125	242	H	426512	4663671	3801	3
1126	372	H	426512	4663671	5088	3
1127	410	H	426512	4663671	5611	3
1128	370	H	426512	4663671	5001	3
1129	425	H	426512	4663671	5633	3
1130	124	H	426664	4664808	1471	2
1131	158	H	426664	4664808	1851	2
1132	189	H	426664	4664808	3206	2
1133	202	H	426664	4664808	3471	2
1134	275	H	426664	4664808	4162	2
1135	302	H	426664	4664808	4383	2
1136	312	H	426664	4664808	4516	2
1137	374	H	426664	4664808	5088	3
1138	414	H	426664	4664808	5611	2
1139	427	H	426664	4664808	5633	2
1140	141	H	426785	4664086	1812	1
1141	309	H	426785	4664086	4516	1
1142	582	H	426785	4664086	6218	1
1143	145	H	426933	4664195	1812	3
1144	164	H	426933	4664195	2049	3
1145	243	H	426933	4664195	3801	3
1146	256	H	426933	4664195	4049	3
1147	299	H	426933	4664195	4364	3
1148	424	H	426933	4664195	5633	3
1149	590	H	426933	4664195	6224	3
1150	591	H	426933	4664195	6260	3
1151	181	H	426945	4662861	3206	1
1152	199	H	426945	4662861	3471	1
1153	238	H	426945	4662861	3796	1
1154	371	H	426945	4662861	5088	1
1155	420	H	426945	4662861	5633	1
1156	587	H	426945	4662861	6224	1
1157	65	H	427004	4661452	1150	4
1158	34	H	427040	4662048	682	3
1159	144	H	427040	4662048	1812	3
1160	201	H	427040	4662048	3471	2

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1161	264	H	427040	4662048	4103	3
1162	270	H	427040	4662048	4138	3
1163	583	H	427040	4662048	6218	3
1164	604	H	427040	4662048	7257	3
1165	209	H	427458	4664577	3604	1
1166	397	H	427458	4664577	5321	1
1167	438	H	427458	4664577	5674	1
1168	474	H	427458	4664577	5970	1
1169	532	H	427458	4664577	6078	1
1170	18	H	427560	4664467	674	1
1171	112	H	427560	4664467	1462	1
1172	156	H	427560	4664467	1851	1
1173	183	H	427560	4664467	3206	1
1174	328	H	427560	4664467	4839	1
1175	33	H	427615	4663046	682	3
1176	178	H	427615	4663046	3187	3
1177	262	H	427615	4663046	4103	3
1178	269	H	427615	4663046	4138	3
1179	600	H	427615	4663046	7257	3
1180	134	H	427733	4652450	1591	1
1181	293	H	427733	4652450	4364	1
1182	531	H	427733	4652450	6078	1
1183	380	H	427798	4644328	5265	1
1184	85	H	427897	4667704	1355	3
1185	409	H	427897	4667704	5611	3
1186	578	H	427897	4667704	6078	3
1187	616	H	427897	4667704	7522	3
1188	133	H	427957	4651678	1591	1
1189	308	H	427957	4651678	4464	1
1190	342	H	427957	4651678	4859	1
1191	395	H	427957	4651678	5321	1
1192	155	H	428063	4651691	1851	1
1193	613	H	428063	4651691	7334	2
1194	636	H	428063	4651691	8109	1
1195	72	H	428191	4664460	1198	1
1196	349	H	428191	4664460	4931	1
1197	472	H	428191	4664460	5970	1
1198	42	H	428238	4664983	816	3
1199	80	H	428238	4664983	1225	3
1200	455	H	428238	4664983	5812	3
1201	544	H	428238	4664983	6078	3
1202	185	H	428287	4651505	3206	3
1203	597	H	428287	4651505	6833	3
1204	245	H	428318	4661776	3844	3
1205	295	H	428318	4661776	4364	3
1206	142	H	428405	4637571	1812	3
1207	310	H	428405	4637571	4516	3
1208	331	H	428405	4637571	4839	3
1209	408	H	428405	4637571	5611	3
1210	612	H	428405	4637571	7334	3
1211	615	H	428405	4637571	7522	3
1212	1	H	428500	4651147	621	1
1213	105	H	428500	4651147	1432	1
1214	130	H	428500	4651147	1591	1
1215	581	H	428500	4651147	6218	1
1216	180	H	428648	4651156	3206	1
1217	592	H	428648	4651156	6561	1
1218	110	H	428668	4637663	1462	1

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1219	217	H	428668	4637663	3659	1
1220	394	H	428668	4637663	5321	1
1221	433	H	428668	4637663	5662	1
1222	446	H	428668	4637663	5684	1
1223	528	H	428668	4637663	6078	1
1224	623	H	428706	4650752	7723	1
1225	17	H	428706	4650752	674	1
1226	103	H	428706	4650752	1432	1
1227	129	H	428706	4650752	1591	1
1228	279	H	428706	4650752	4268	1
1229	389	H	428706	4650752	5265	1
1230	608	H	428706	4650752	7334	1
1231	106	H	428709	4651052	1432	2
1232	323	H	428709	4651052	4815	2
1233	584	H	428709	4651052	6218	2
1234	625	H	428709	4651052	7723	1
1235	208	H	428709	4651052	3604	1
1236	530	H	428709	4651052	6078	1
1237	610	H	428709	4651052	7334	1
1238	48	H	428729	4666068	836	3
1239	480	H	428729	4666068	5970	3
1240	84	H	428772	4651296	1355	1
1241	132	H	428772	4651296	1591	1
1242	467	H	428772	4651296	5970	1
1243	593	H	428772	4651296	6561	1
1244	354	H	428877	4664548	4931	1
1245	104	H	428971	4650768	1432	1
1246	321	H	428971	4650768	4815	1
1247	44	H	428971	4650768	836	1
1248	609	H	428971	4650768	7334	1
1249	611	H	428974	4650750	7334	1
1250	184	H	429000	4651000	3206	3
1251	109	H	429003	4655166	1462	3
1252	391	H	429003	4655166	5265	3
1253	398	H	429052	4638255	5321	3
1254	450	H	429052	4638255	5684	3
1255	566	H	429052	4638255	6078	3
1256	320	H	429187	4650527	4815	1
1257	348	H	429187	4650527	4931	1
1258	386	H	429187	4650527	5265	1
1259	621	H	429187	4650527	7723	1
1260	90	H	429187	4650527	1357	1
1261	221	H	429187	4650527	3659	1
1262	278	H	429187	4650527	4268	1
1263	387	H	429187	4650527	5265	1
1264	607	H	429187	4650527	7334	1
1265	5	H	429778	4638964	628	1
1266	39	H	429778	4638964	683	1
1267	111	H	429778	4638964	1462	1
1268	172	H	429778	4638964	2660	1
1269	369	H	429778	4638964	5001	1
1270	52	H	429902	4658401	836	2
1271	268	H	429902	4658401	4138	2
1272	423	H	429902	4658401	5633	2
1273	533	H	429902	4658401	6078	2
1274	375	H	429902	4658401	5088	3
1275	10	H	430002	4638082	628	3
1276	57	H	430002	4638082	836	3

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Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1277	163	H	430002	4638082	2049	3
1278	298	H	430002	4638082	4364	3
1279	435	H	430002	4638082	5662	3
1280	448	H	430002	4638082	5684	3
1281	546	H	430002	4638082	6078	3
1282	618	H	430002	4638082	7522	3
1283	154	H	430040	4638708	1851	1
1284	253	H	430040	4638708	4049	1
1285	261	H	430040	4638708	4103	1
1286	432	H	430040	4638708	5662	1
1287	366	H	430312	4638996	4998	3
1288	4	H	430602	4654517	621	2
1289	54	H	430602	4654517	836	2
1290	285	H	430602	4654517	4268	2
1291	482	H	430602	4654517	5970	2
1292	536	H	430602	4654517	6078	2
1293	87	H	430602	4654517	1355	2
1294	116	H	430602	4654517	1462	2
1295	160	H	430602	4654517	2049	2
1296	170	H	430602	4654517	2518	2
1297	212	H	430602	4654517	3604	2
1298	240	H	430602	4654517	3796	2
1299	296	H	430602	4654517	4364	2
1300	434	H	430602	4654517	5662	2
1301	454	H	430602	4654517	5812	2
1302	588	H	430602	4654517	6224	2
1303	599	H	430602	4654517	7257	2
1304	56	H	431000	4658750	836	2
1305	64	H	431000	4658750	1100	2
1306	76	H	431000	4658750	1198	2
1307	213	H	431000	4658750	3604	2
1308	333	H	431000	4658750	4839	2
1309	373	H	431000	4658750	5088	2
1310	190	H	431000	4658750	3420	2
1311	377	H	431382	4659333	5088	3
1312	379	H	431382	4659333	5249	3
1313	526	H	431972	4638972	6078	1
1314	58	H	432533	4660964	836	3
1315	77	H	432533	4660964	1198	3
1316	550	H	432533	4660964	6078	3
1317	570	H	432568	4645352	6078	3
1318	499	H	432711	4658872	5970	1
1319	188	H	433910	4659156	3206	2
1320	66	H	434082	4659709	1198	1
1321	45	H	434082	4659709	836	1
1322	9	H	434595	4642478	628	3
1323	535	H	434595	4642478	6078	3
1324	361	H	434595	4642478	4931	2
1325	59	H	434595	4642478	836	3
1326	119	H	434595	4642478	1462	3
1327	462	H	434595	4642478	5919	3
1328	47	H	434695	4642263	836	1
1329	637	H	435001	4663044	8112	3
1331	1	L	426503	4657441	682	1
1332	2	L	426523	4658468	682	1
1333	3	L	426713	4658457	682	1
1334	4	L	426385	4658673	682	1
1335	5	L	426270	4658699	682	1

Continue Table D

Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1336	7	L	427083	4659354	682	1
1337	8	L	426635	4658843	682	1
1338	9	L	427086	4658906	682	1
1339	10	L	427080	4659054	682	1
1340	11	L	426503	4657441	1075	1
1341	12	L	426523	4658468	1075	1
1342	13	L	426713	4658457	1075	1
1343	14	L	426385	4658673	1075	1
1344	15	L	426270	4658699	1075	1
1345	17	L	427083	4659354	1075	1
1346	18	L	426635	4658843	1075	1
1347	19	L	426713	4658457	1562	1
1348	20	L	426385	4658673	1562	1
1349	21	L	426270	4658699	1562	1
1350	22	L	426713	4658457	3187	1
1351	23	L	426635	4658843	3187	1
1352	24	L	426523	4658468	3206	1
1353	25	L	425524	4659246	3207	1
1354	26	L	426865	4658668	3207	1
1355	27	L	426246	4656185	3207	1
1356	28	L	427086	4658906	3207	1
1357	29	L	426713	4658457	3796	1
1358	30	L	427083	4659354	3796	1
1359	31	L	426996	4658420	3796	1
1360	32	L	427086	4658906	3796	1
1361	33	L	427080	4659054	3796	1
1362	34	L	426523	4658468	3844	1
1363	35	L	425524	4659246	3844	1
1364	36	L	426865	4658668	3844	1
1365	37	L	426996	4658420	3844	1
1366	38	L	426790	4658073	3844	1
1367	39	L	426246	4656185	3844	1
1368	40	L	427086	4658906	3844	1
1369	41	L	427080	4659054	3844	1
1370	42	L	426523	4658468	4162	1
1371	43	L	426713	4658457	4162	1
1372	44	L	427083	4659354	4162	1
1373	45	L	426635	4658843	4162	1
1374	46	L	426523	4658468	4364	1
1375	47	L	426865	4658668	4364	1
1376	48	L	426996	4658420	4364	1
1377	49	L	426246	4656185	4364	1
1378	50	L	427086	4658906	4364	1
1379	51	L	427080	4659054	4364	1
1380	52	L	426523	4658468	4998	1
1381	53	L	426713	4658457	4998	1
1382	54	L	426270	4658699	4998	1
1383	55	L	425524	4659246	4998	1
1384	56	L	426996	4658420	4998	1
1385	57	L	426246	4656185	4998	1
1386	58	L	427080	4659054	4998	1
1387	59	L	426503	4657441	5633	1
1388	60	L	426523	4658468	5633	1
1389	61	L	426713	4658457	5633	1
1390	62	L	426385	4658673	5633	1
1391	63	L	426270	4658699	5633	1
1392	65	L	425524	4659246	5633	1
1393	66	L	426790	4658073	5633	1

Continue Table D

Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1394	67	L	426246	4656185	5633	1
1395	68	L	427086	4658906	5633	1
1396	69	L	425524	4659246	7257	1
1397	70	L	426865	4658668	7257	1
1398	71	L	426996	4658420	7257	1
1399	72	L	426790	4658073	7257	1
1400	73	L	426246	4656185	7257	1
1401	74	L	427086	4658906	7257	1
1402	75	L	427080	4659054	7257	1
1403	76	L	426503	4657441	7522	1
1404	77	L	425524	4659246	7522	1
1405	78	L	426246	4656185	7522	1
1406	79	L	427086	4658906	7522	1
1407	1	I	428902	4658729	591	2
1408	2	I	426811	4661204	591	3
1409	3	I	430936	4663604	628	2
1410	4	I	430936	4663604	628	2
1411	5	I	426608	4661641	628	2
1412	6	I	426608	4661641	628	2
1413	7	I	431668	4654120	674	2
1414	8	I	431668	4654120	674	2
1415	9	I	433069	4664184	674	2
1416	10	I	420926	4651655	674	3
1417	11	I	429896	4654133	674	2
1418	12	I	431668	4654120	836	2
1419	13	I	431668	4654120	836	2
1420	14	I	432399	4664006	836	2
1421	15	I	429342	4654581	836	2
1422	16	I	427608	4664790	836	2
1423	17	I	427608	4664790	836	2
1424	18	I	428227	4643666	937	2
1425	19	I	431668	4654120	943	2
1426	20	I	433069	4664184	944	2
1427	21	I	432399	4664006	944	2
1428	22	I	431000	4654481	944	2
1429	23	I	432399	4664006	944	2
1430	24	I	431000	4654481	944	2
1431	25	I	432399	4664006	1198	3
1432	26	I	431010	4654473	1198	2
1433	27	I	431010	4654473	1198	2
1434	28	I	432399	4664006	1198	3
1435	29	I	432399	4664006	1225	2
1436	30	I	432399	4664006	1225	2
1437	31	I	430973	4663433	1225	2
1438	32	I	430973	4663433	1225	2
1439	33	I	431000	4654481	1357	2
1440	34	I	420926	4651655	1358	3
1441	35	I	420926	4651655	1358	3
1442	36	I	420926	4651655	1358	3
1443	37	I	431453	4663245	1358	3
1444	38	I	432399	4664006	1471	2
1445	39	I	430973	4663433	1471	2
1446	40	I	427327	4662552	1759	3
1447	41	I	432399	4664006	1759	2
1448	42	I	427608	4664790	1759	2
1449	43	I	426811	4661204	1819	3
1450	44	I	430973	4663433	1851	2
1451	45	I	430936	4663604	1851	2

Continue Table D

Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1452	46	I	430936	4663604	1851	2
1453	47	I	430936	4663604	1851	2
1454	51	I	420926	4651655	2374	3
1455	52	I	420926	4651655	2374	3
1456	53	I	420926	4651655	2374	3
1457	56	I	419816	4637988	2845	2
1458	57	I	419816	4637988	2845	2
1459	58	I	423300	4639766	3037	2
1460	59	I	426811	4661204	3471	3
1461	60	I	426811	4661204	3471	3
1462	61	I	431668	4654120	3659	2
1463	62	I	423300	4639766	3659	2
1464	63	I	417604	4667892	3659	3
1465	64	I	417604	4667892	3659	3
1466	65	I	422627	4661557	3659	2
1467	66	I	422627	4661557	3659	2
1468	67	I	423300	4639766	4049	2
1469	68	I	423300	4639766	4049	2
1470	69	I	430480	4664205	4162	3
1471	70	I	422627	4661557	4162	2
1472	71	I	432100	4655000	4268	2
1473	72	I	432810	4656016	4268	2
1474	73	I	431668	4654120	4268	2
1475	74	I	432810	4656016	4268	2
1476	75	I	420926	4651655	4268	3
1477	76	I	420926	4651655	4268	3
1478	77	I	430936	4663604	4383	2
1479	78	I	430936	4663604	4383	2
1480	79	I	430266	4663559	4383	3
1481	80	I	426811	4661204	4383	3
1482	81	I	430142	4662996	4384	3
1483	82	I	420067	4637966	4386	3
1484	83	I	420067	4637966	4386	3
1485	84	I	420067	4637966	4386	3
1486	85	I	420067	4637966	4386	3
1487	86	I	431668	4654120	4464	2
1488	87	I	431668	4654120	4464	2
1489	88	I	431668	4654120	4464	2
1490	89	I	433069	4664184	4516	2
1491	90	I	433069	4664184	4516	2
1492	91	I	430480	4664205	4516	3
1493	92	I	427327	4662552	4516	3
1494	93	I	432100	4655000	4815	2
1495	94	I	431000	4654481	4815	2
1496	95	I	431000	4654481	4815	2
1497	96	I	430123	4654566	4815	3
1498	97	I	422627	4661557	4815	2
1499	98	I	430973	4663433	4839	2
1500	99	I	430973	4663433	4839	2
1501	100	I	430313	4663402	4839	2
1502	101	I	432100	4655000	4859	2
1503	102	I	432810	4656016	4859	2
1504	103	I	426472	4647627	4998	2
1505	104	I	426472	4647627	4998	2
1506	105	I	426703	4645431	4998	3
1507	106	I	426703	4645431	4998	3
1508	107	I	431657	4655138	5001	3
1509	108	I	431041	4657004	5001	2

Continue Table D

Object ID	Original ID	Source	X	Y	Checklist code	Spatial accuracy
1510	109	I	430480	4664205	5001	3
1511	110	I	432410	4659697	5249	2
1512	111	I	432410	4659697	5249	2
1513	112	I	431668	4654120	5265	2
1514	113	I	432100	4655000	5265	2
1515	114	I	432100	4655000	5265	2
1516	115	I	431668	4654120	5265	2
1517	116	I	431668	4654120	5265	2
1518	117	I	432100	4655000	5321	2
1519	118	I	432100	4655000	5321	2
1520	119	I	433069	4664184	5321	2
1521	120	I	430123	4654566	5321	3
1522	121	I	427826	4648464	5322	2
1523	122	I	427608	4664790	5611	2
1524	123	I	427608	4664790	5611	2
1525	124	I	431453	4663245	5633	3
1526	125	I	426811	4661204	5633	3
1527	126	I	430281	4661227	5633	2
1528	127	I	430281	4661227	5633	2
1529	128	I	431453	4663245	5634	3
1530	129	I	425207	4651363	5662	2
1531	130	I	425207	4651363	5662	2
1532	131	I	428480	4668327	5674	3
1533	132	I	428480	4668327	5674	3
1534	133	I	428480	4668327	5674	3
1535	134	I	428480	4668327	5674	3
1536	135	I	428227	4643666	5684	2
1537	136	I	428227	4643666	5684	2
1538	137	I	426703	4645431	5812	3
1539	138	I	426703	4645431	5812	3
1540	139	I	426136	4649867	5970	2
1541	140	I	431000	4654481	5970	2
1542	141	I	431000	4654481	5970	2
1543	142	I	433699	4663874	5970	2
1544	143	I	417604	4667892	6074	2
1545	144	I	423300	4639766	6074	2
1546	145	I	417604	4667892	6075	2
1547	146	I	426136	4649867	6075	2
1548	147	I	430123	4654566	6078	3
1549	148	I	430811	4654631	6079	2
1550	149	I	432100	4655000	6079	2
1551	150	I	430936	4663604	6079	2
1552	151	I	430123	4654566	6079	3
1553	152	I	430123	4654566	6080	3
1554	153	I	429167	4658632	6224	2
1555	154	I	428902	4658729	6224	2
1556	155	I	426811	4661204	6224	3
1557	156	I	423300	4639766	7029	2
1558	157	I	423300	4639766	7029	2
1559	158	I	430480	4664205	7522	3
1560	160	I	420926	4651655	7723	3
1561	161	I	429167	4658632	8270	2
1562	162	I	429073	4659446	8270	2

* :“Object ID” is the ID in the shape file.

** :”Oranginal ID” is the ID in the source file

*** :In the ”Source” column B-Bibliographic, H-Herbarium, L- Romeo Di Pietro I- Index Seminum

Table E The combined geodatabase of *Achillea barrelieri* subsp. *barrelieri*

ID	X	Y	Presence =1 Absence = 0
1	426933	4664200	1
2	426400	4661100	1
3	425790	4661200	1
4	426200	4659500	1
5	426664	4664810	1
6	426945	4662860	1
7	429902	4658400	1
8	426503	4657440	1
9	426523	4658470	1
10	426713	4658460	1
11	426385	4658670	1
12	426270	4658700	1
13	425524	4659250	1
14	426790	4658070	1
15	426246	4656180	1
16	427086	4658910	1
17	430281	4661230	1
18	430281	4661230	1
19	429408	4643930	0
23	419787	4648120	0
24	424098	4649620	0
25	432644	4645080	0
30	415618	4672820	0
32	428155	4658730	0
33	409070	4671020	0
36	417426	4662540	0
37	417357	4659500	0
39	429224	4671110	0
44	423621	4673020	0
45	416608	4640660	0
48	423109	4658330	0
52	422935	4674700	0
56	424870	4639820	0
57	410419	4662590	0
58	413375	4660130	0
62	422983	4662360	0
64	416060	4673040	0

Continue to Table E

ID	X	Y	Presence =1 Absence = 0
65	420658	4668020	0
67	434695	4635560	0
68	413076	4665660	0
69	417586	4639460	0
70	430043	4668730	0
71	431171	4660600	0
72	415364	4663770	0
73	412911	4661430	0
76	425759	4646410	0
79	434515	4645510	0
81	423053	4674750	0
88	435548	4641550	0
94	415685	4669230	0
96	412244	4662100	0
98	428853	4659580	0
100	426650	4646720	0
102	431460	4637030	0
103	436434	4645650	0
106	419823	4638190	0

Table F The combined geodatabase of *Adonis distorta*

ID	X	Y	Presence =1 Absence = 0
1	424264	4661970	1
2	425171	4657170	1
3	425736	4658620	1
4	425219	4661190	1
5	426400	4661100	1
6	425790	4661200	1
7	426503	4657440	1
8	426523	4658470	1
9	426713	4658460	1
10	426385	4658670	1
11	426270	4658700	1
12	427083	4659350	1
13	426635	4658840	1
15	411127	4664780	0
22	425391	4635230	0
24	420183	4636890	0
25	430911	4657520	0
36	433323	4664700	0
37	423608	4659410	0
39	410881	4663220	0
47	421218	4643530	0
48	424242	4644670	0
53	418907	4657580	0
56	422721	4673860	0
57	427158	4658410	0
58	429006	4661180	0
62	435285	4642120	0
64	426582	4641010	0
71	416217	4664750	0
72	430089	4663280	0
73	432583	4664300	0

The Script of R

```
library(gstat)
library(spatstat)
library(splancs)
library(rgdal)
library(lattice)
library(RSAGA)

# Check the default RSAGA environment on your computer:
rsaga.env()

# Check the working direction on your computer:
getwd()
setwd("/Data_R_1075")

# Load the data:
file.show("grids.txt")
file.show("p1075.txt")
file.show("1075weight.txt")
grids <-read.table("grids.txt", header=T)
p1075 <-read.table("p1075.txt", header=T)
p1075table <-read.table("p1075.txt", header=T)
w1075 <-read.table("1075weight.txt", header=T)
grids
p1075
p1075table
w1075
coordinates(grids) <- c("X", "Y")
coordinates(p5633) <- c("X", "Y")
coordinates(w5633) <- c("X", "Y")
str(grids)
str(p1075)
str(w1075)
plot(grids)
plot(p1075)
plot(w1075)
class(grids)
p1075.pnt <- data.frame(x=p1075table$X, y=p1075table$Y, no=rep(1, length(p1075table$X)))
coordinates(p1075.pnt) <- ~x+y
str(p1075.pnt)
p1075.pnt
plot(p1075.pnt)

# Making a grids
gridded(grids) = TRUE
grids <- as(grids, "SpatialGridDataFrame")
image(grids)

#------------------------------
```

```
# Simulation of the pseudo-absence locations
#-------------------------------

# first the buffer distance:
rsaga.geoprocessor(lib="grid_gridding", module=3, param=list(GRID="p1075_buffer.sgrd",
        SHAPES="p1075.shp",
FIELD=0, USER_CELL_SIZE=grids@grid@cellsize[[1]],
USER_X_EXTENT_MIN=grids@bbox[1,1]+grids@grid@cellsize[[1]]/2,
USER_X_EXTENT_MAX=grids@bbox[1,2]-grids@grid@cellsize[[1]]/2,
USER_Y_EXTENT_MIN=grids@bbox[2,1]+grids@grid@cellsize[[1]]/2,
USER_Y_EXTENT_MAX=grids@bbox[2,2]-grids@grid@cellsize[[1]]/2))

# now extract a buffer distance map and load it back to R:
# the parameters DIST and IVAL are estimated based on the grid properties:
rsaga.geoprocessor(lib="grid_tools", module=10, param=list(SOURCE="p1075_buffer.sgrd",
DISTANCE="p1075_dist.sgrd", ALLOC="p1075_alloc.sgrd", BUFFER="p1075_bdist.sgrd",
# DGR: original divided by 3, to narrow the buffer we divide by 5
# Chang: consider the range of area and make the time of DIST
DIST=4*(sqrt(areaSpatialGrid(grids)))/5, IVAL=grids@grid@cellsize[[1]]))

rsaga.sgrd.to.esri(in.sgrds="p1075_dist.sgrd", out.grids="p1075_dist.asc", out.path=getwd(), prec=1)
rsaga.sgrd.to.esri(in.sgrds="p1075_buffer.sgrd", out.grids="p1075_buffer.asc", out.path=getwd(), prec=1)

grids$buffer <- readGDAL("p1075_dist.asc")$band1

grids$bufferr <- grids$buffer/max(grids$buffer, na.rm=T)

# extrapolation weight:
grids$weight <- ((100*grids$bufferr+(100-w1075$RASTERVALU))/2)^2
dens.weight <- as.im(as.image.SpatialGridDataFrame(grids["weight"]))
image(dens.weight)
# 1time is not enough for this research
p1075.absences <- rpoint(5*(length(p1075.pnt$no)), f=dens.weight)
p1075.absences <- data.frame(x=p1075.absences$x, y=p1075.absences$y ,no=rep(0, length(p1075.pnt$no)))
coordinates(p1075.absences) <- ~x+y
plot(p1075.absences)

# combbine the occurences and absences:
all1075<- rbind(p1075.pnt["no"], p1075.absences["no"])
plot(all1075, col=all1075$no+1)
all1075

# Before doing IK, clip by the boundary and make RPA*.txt(ID, X, Y, code)

#--------------------
# Indicator Kriging
#--------------------

# Load the data:
```

```
file.show("RPA1075.txt")
PA1075 <-read.table("RPA1075.txt", header=T)
PA1075
coordinates(PA1075) <- c("X", "Y")

# Making a grids
file.show("grids.txt")
grids <-read.table("grids.txt", header=T)
coordinates(grids) <- c("X", "Y")
gridded(grids) = TRUE
image(grids)


# Computing variograms
vPA1075 <- variogram(code ~ 1, loc = PA1075, cloud = T)
print(plot(vPA1075, main = "Indicator variogram cloud, PA1075"))
vPA1075 <- variogram(code ~ 1, loc = PA1075, cutoff=10000)
print(plot(vPA1075, pl = T, main = "Indicator variogram, PA1075"))

# Model the variogram
(vPA1075f <- fit.variogram(vPA1075, vgm(0.3, "Gau", 6000, 0.07)))
print(plot(vPA1075, pl = T, main = "Modelled indicator variogram, PA1075", model = vPA1075f))

# Indicator kriging
kPA1075 <- krige(code ~ 1, loc = PA1075, newdata = grids, model = vPA1075f)
summary(kPA1075)

#  Limit the predicted probabilities to the range [0..1]
kPA1075$var1.pred <- pmin(1, kPA1075$var1.pred)
kPA1075$var1.pred <- pmax(0, kPA1075$var1.pred)
summary(kPA1075)

#  Plot the probability of the indicator
print(spplot(kPA1075, zcol = "var1.pred", at = seq(0,1, by = 0.1), col.regions = heat.colors(64), main =
        "Probability PA1075",
sub = "Indicator Kriging"))
layout.PA1075 <- list("sp.points", PA1075, col = ifelse(PA1075$code,"green", "blue"), pch = 20)
plot.kPA1075 <- spplot(kPA1075, zcol = "var1.pred", at = seq(0,1, by = 0.1), col.regions = heat.colors(64), main
        = "Adonis distorta distribution map",
sub = "Indicator Kriging", sp.layout = list(layout.PA1075))
print(plot.kPA1075)
```