



## Habitat evaluation of Levantine viper (*Macrovipera lebetina* Linnaeus, 1758) in Haftad-Gholleh protected area, Iran

**Amir Ansari**

Department of Environmental Sciences, Faculty of Natural Resources, Arak University, Iran  
email: a\_ansari645@yahoo.com

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### Abstract

Haftad-Gholleh protected area located in central plateau of Iran host one of the mountainous vipers, Levantine viper (*Macrovipera lebetina*) which can be regarded as west and northeastern subspecies. Habitat destruction and illegal live trapping to extract venom can be considered as some of the most important factors which threatens the species viability. To determine the most important factors which affect the species habitat use, I tried to use to modeling approaches of MaxEnt and Logistic regression focusing on the eight different independent variables and 15 locations of the species presence. Both models with high validation criteria (AUC > 0.98) indicated that around one percent of the protected area can be regarded as a potential habitat for the target species. Two distal factors acted in reverse direction as distance from the Human related landuse (7 km) showed the highest priority while the distance from traffic roads indicated the lowest effect on the species habitat usage. Two other most important variables which affect the species habitat selection were distance to the water resources and altitude. The present work's outputs can be used in the species protection in Haftad-Gholleh protected area.

**Keywords:** Habitat modeling, Logistic regression, *Macrovipera lebetina*, MaxEnt modeling approach.

### Introduction

Levantine viper (*Macrovipera lebetina*) has been recorded from central Asia and the Middle East (Ananjeva *et al.* 2006, Gçmen *et al.* 2006). Montivipera genus include three species of *M. latifii*, *M. kuhrangica* and *M. raddei* in Iran (Rajabizadeh 2011) however there is debate on the number of species and subspecies yet (Rastegar Pouyani *et al.* 2014). Montivipera genus members are restricted to the mountainous habitats of Iran-Anatolian region and regarding their selected habitat variables in such a fragile ecosystems, they are more sensitive to the potential threatening factors (Latifi 2000, Rajabizadeh *et al.* 2011). Habitat destruction and illegal live trapping to extract venom for medical purposes threatens their viability (Kian *et al.* 2011, Esmaili Jahromi *et al.* 2016). Previous investigations indicates that *M. lebetina* is the only venomous reptile throughout the study area which needs special conservation consideration (Salemi *et al.* 2015). Levantine viper usually can be found in average temperature of 46.28 °C, moisture around 16% and lavational range of 2138.73 meters above sea level with maximum activity in June (Pashaeirad *et al.* 2016). Except Pashaeirad *et al.* (2016) study, there is no other documented research in Iran which describe the species habitat affinities (Asadi *et al.* 2014), however, similar investigations had been carried out on other vipers like *Vipera albicornuta* (Sheikhii *et al.* 2012). Habitat modeling of *V. albicornuta* using logistic regression analysis and selecting input variables of altitude, terrain slope, azimuth, land properties (bare soil, rocky areas and etc.) and distal factors in 25 recorded localities indicated that the rocks percentage coverage play the most important role in the species habitat use (sheikhii *et al.* 2013). MaxEnt modeling approach is one of the most common algorithms in machine-based learning investigations which is based on the maximum entropy theory (Phillips *et al.* 2006). Describes

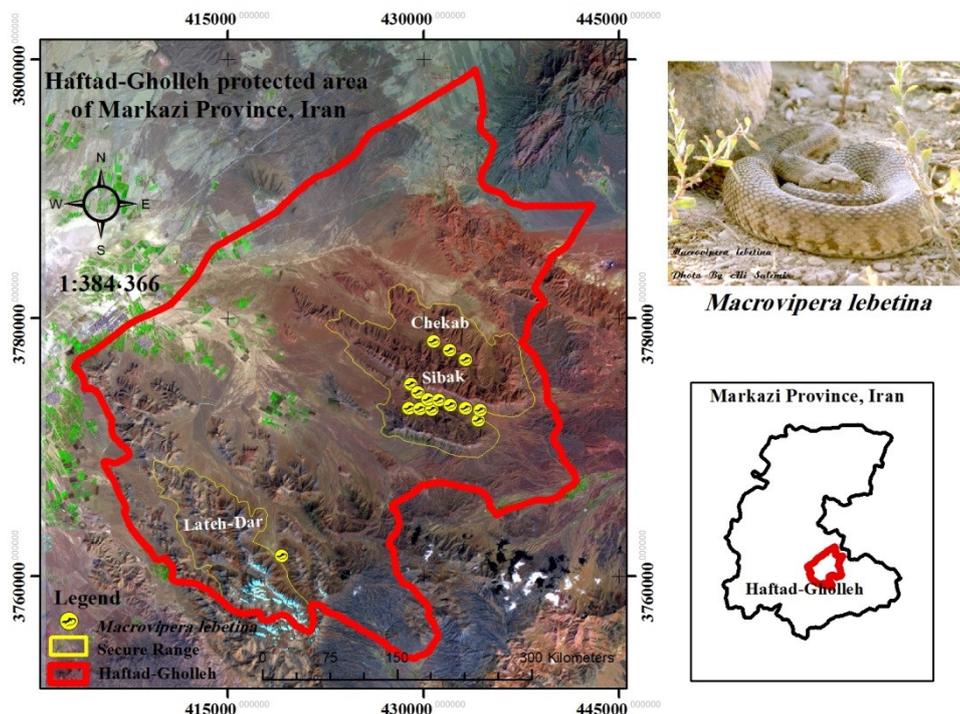
the entropy as a criterion for the number of involved choices in the case of an event occurrence (Behdarvand 2012). Determining the status of wildlife species distribution and their habitat affinities has great importance in the wildlife management and conservation. To this aim, I tried to get a habitat suitability model for the target species and help local authorities to enhance the conservation programs quality toward the targeted vipers' protection and conservation.

## Material and Methods

### Study Area

With an area of more than 97400 ha, Haftad-Gholleh protected area (Fig. 1) located 25 km from the eastern Arak and 15 km of Mahallat city (33°, 55' to 34°, 20' N and 49°, 56' to 50°, 24' E). Mean annual rainfall in the study area is about 349 mm and temperature fluctuate from -30 to 38°C. This mountainous protected areas host wild goat (*Capra aegagrus*), wild sheep

(*Ovis orientalis*), Persian leopard (*Panthera pardus*), Wolves (*Canis lupus*), Wild cat (*Felis silvestris*), Caracal (*Caracal caracal*), Badger (*Meles meles*), Hedgehog (*Erinaceus concolor*), Spur-thighed tortoise (*Testudo graeca*), Common hyena (*Hyaena hyaena*), Fox (*Vulpes vulpes*), Jackal (*Canis aureus*), Indian crested porcupine (*Hystrix indica*), Houbara bustard (*Chlamydotis undulata*), Perdicinae (*Alectoris chukar*) blackbellied sandgrouse (*Pterocles orientalis*). Different families from snakes can be found in the study area like: Typhlopidae (*Xerotyphlops vermicularis*), Viperidae (*Macrovipera lebetina*), Boidae (*Eryx miliaris* and *E. tataricus*), Lamprophiidae (*Malpolon insignitus*), Colubridae (*Eirenis punctatolineatus*, *E. collaris*, *Platyceps ventromaculatus*, *Platyceps najadum*, *Hemorrhhois ravergeri* and *Natrix tessellate* (Salemi *et al.* 2015).



**Figure 1.** The location of the study area in Markazi province, Iran

At first, a 1:50000 digital elevation map of the study region converted to a raster map with 30×30 pixel size and variable groups like topographical and distal were extracted. In a random basis, I tried to collect the species points by traversing line transects on foot and totally 15

activity points were recorded. Moving in a randomly selected direction up to around 500 m from the species observation point, can be located as an absence point after intensive search in a circular plot of 30 m radius (Sahragard and Ajorlo 2018). Variables were

selected by reviewing the literature (Brito 2003, Luiselli 2006, Lagory *et al.* 2009, Sheikhi *et al.* 2012) and measured at the species' presence points. Some of the human activity related variables like distance to the farms, human settlements and livestock husbandry areas as well as distance from the traffic roads were measured as well (Sheikhi *et al.* 2013). MaxEnt and Logistic regression method were used for habitat modeling and criteria like Area Under ROC (the receiver operating characteristic) curves was used for compare the model ability

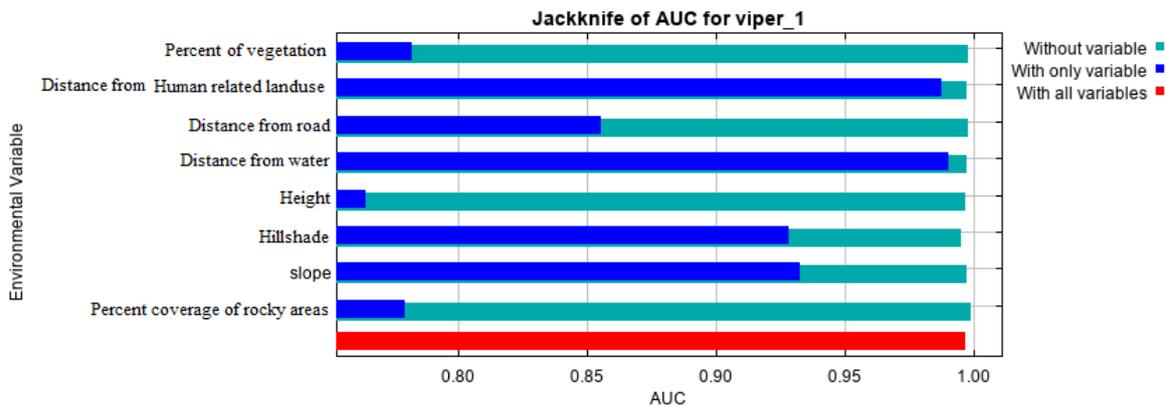
to predict the most suitable areas and affecting variables (Phillips *et al.* 2006). AUC as a single threshold-independent measurement of model performance can be used as an important criteria (Thuiller *et al.* 2005).

### Results

MaxEnt model indicated the importance of the water resources in the species habitat use (Fig. 3). Other most important variables have been presented in table 1.

**Table 1.** Percent contribution and significance of each variables in MaxEnt model of species habitat use.

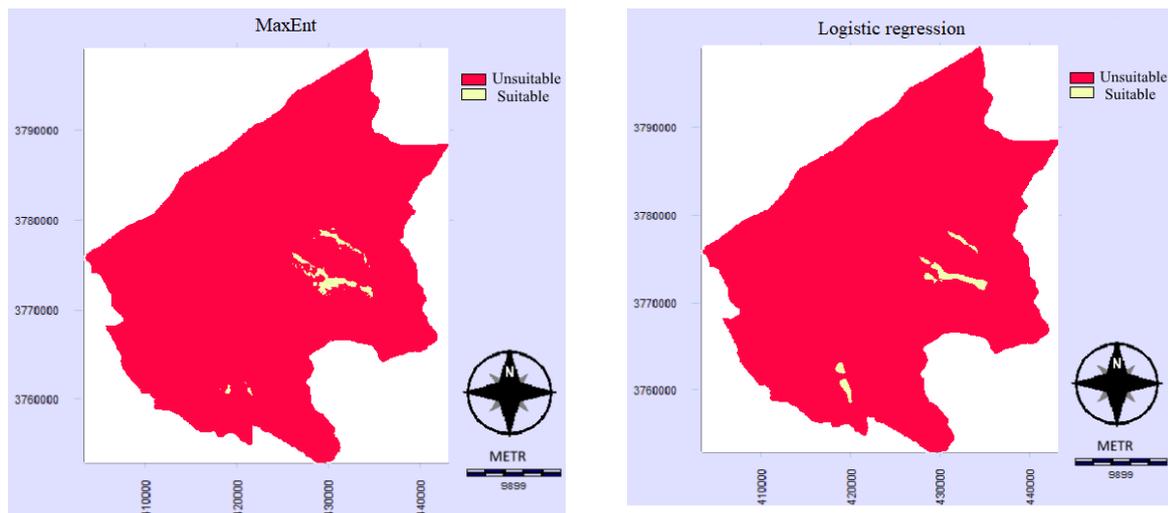
Variable	Percent contribution	Permutation importance	Optimal conditions
Distance from water resources	46.6	92.9	0
Percent of vegetation	19.9	0	75-100%
Percent coverage of rocky areas	19.5	4.4	50-75%
Distance from Human related landuse	7.1	0	7 km
Slope	6.3	2.2	5-10 (degrees)
Azimuth	0.4	0.6	250
Distance from traffic roads	0.2	0	2700 m
elevation	0	0	2900 m



**Figure 2.** The jackknife test results for the significance of each variable

Figure 2. Jackknife test of variable importance which help to identify those variables has more contribution in the outputted model. This test indicated that the presence of the water

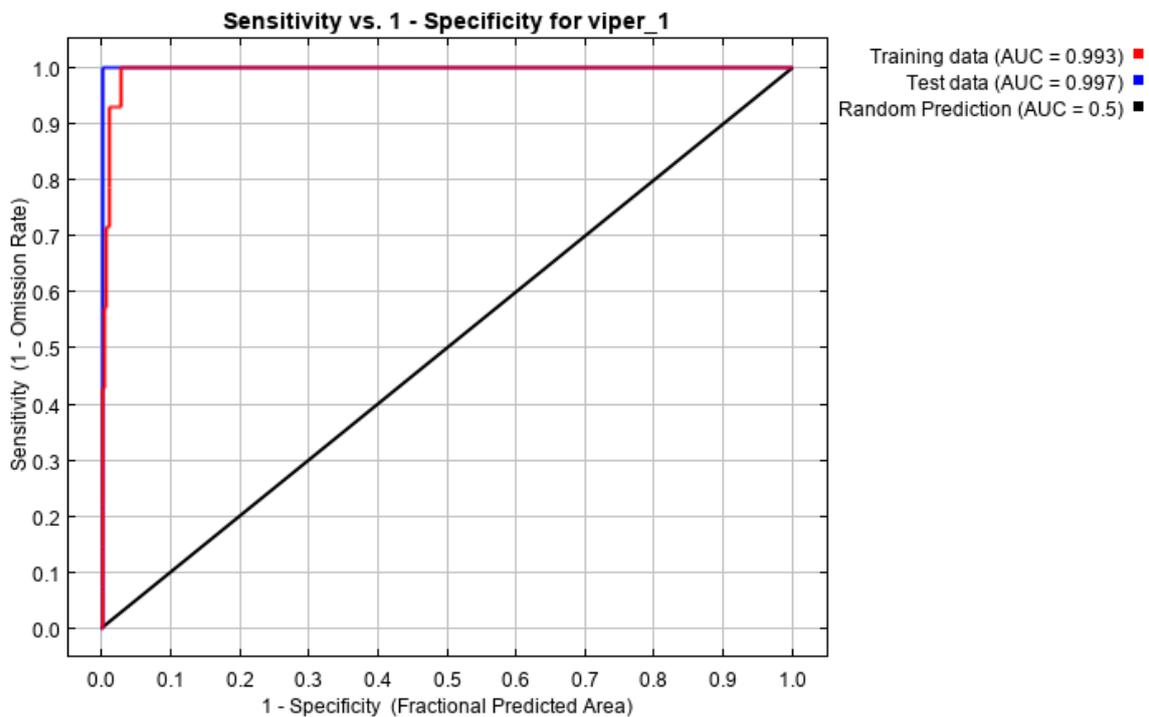
resources, distance from the Human related landuse, terrain slope and elevation from sea level (altitude) had the most contribution.



**Figure 3.** Habitat suitability models for the target species based on two modeling approach of Maximum Entropy and Logistic regression.

Both modeling approaches indicated that around 1.03 percent of the protected area can be regarded as potentially suitable habitats for this viper (Fig. 4). The percent coverage of the

potentially suitable habitats resulted from two modeling approaches has been presented in table 2.



**Figure 4.** The receiver operating characteristic (ROC) in MaxEnt modeling procedure

The percent and suitable habitat area of the models using the MaxEnt and Logistic regression are present in Table 2. Comparing the models' validity in Table2 shows that the validity of the maximum entropy model is 0.997

and the Logistic regression is 0.985, suggesting that the MaxEnt model has a better predictability for the presence points with the probability of 989% that confirms its high validity.



**Table 2.** The percent coverage of the suitable habitats using two different modeling approaches as well as value of the receiver operating characteristic

Class name	MaxEnt			Logistic regression		
	Area (ha)	Percent	ROC	Area (ha)	Percent	ROC
Suitable	994.68	1.03	0.997	1002.78	1.03	0.985
Unsuitable	96442.47	98.97		96434.37	98.97	
Total	97437.15	100		97437.15	100	

## Discussion

The ROC criteria indicating the superior performance of both methodologies in the species habitat modeling (Giovanelli *et al.* 2010). The ROC curve plot the sensitivity (the probability of predicting a real positive will be a positive) against 1-specificity (the probability of predicting a real negative will be a positive). Among the human related variables, the highest score has been given to the distance from the Human related landuse (7.1) while the lowest contribution is assigned to the distance from roads (0.2) (Brito 2003). For the ecological variables, the highest contribution rate (46.6), significance (92.9) and distance from the optimum condition (0) are assigned to the presence of the water resources, while the lowest contribution rate (0.1), significance (0), and the optimum condition (2500 m) are obtained for height parameter (Lagory *et al.* 2009). Accordingly, among the development variables, the highest effect on the Levantine viper habitat is related to distance from human uses while the lowest effect is assigned to distance from road. Moreover, among the ecology variables, the highest and lowest impacts are related to distance from water and height, respectively (Luiselli 2006). The most suitable habitats which identified by the models have been located in the the Sibak, Chekab and Lateh-Dar where shows variables like dense plant cover, rocky surfaces, far away from traffic roads and human activity centers, closeness to the water resources, slopes with more capability of sunlight absorption, altitude between 1980 and 2250 meters above sea level, slope of 5 to 10 degrees. These conditions can be found in small parts of the study area where constitute critical parts of the habitat for the target species as well (Pashaeirad *et al.* 2016). Most of the potentially suitable habitat for Levantine viper is located in the core areas of Haftad-Gholleh, which has the lowest human disturbances and the most ideal

environmental conditions like topography, cover and food. The Levantine viper in Iran is certainly deserved of intensive research and conservation efforts as they are currently endangered in local scale and in case of delay in urgent conservational activities, the local extirpation of the species from the study region is not far-fetched. One of the major factors which threatens the species viability, refer back to the habitat fragmentations as a result of the human activity and land use change (Ansari 2009). Knowledge of the ecology of the Levantine viper and its biology should be investigated rapidly to enhance the conservation measures effectiveness. The phylogenetic status of the target population(s) in Haftad-Gholleh protected area and its genetic peculiarities like genetic diversity highly recommended.

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