2.1 STUDY AREA

The newly formed state of Telangana is one of the 29 states of the India with 10 districts contain Telugu speaking people as major population. The State of Telangana was earlier a distinct region of the united Andhra Pradesh which was classically divided in to three geographically separate regions called Circars/Andhra, Rayalaseema and Telangana (Fig. 2.1.1a). The state of Telangana has ten districts (Adilabad, Hyderabad, Karimnagar, Khammam, Mahbubnagar, Medak, Nalgonda, Nizamabad, Ranga Reddy and Warangal).

Fig. 2.1.1a. Map of India showing the location of Telangana State
The state of Telangana is situated between the latitudes 15.49 degrees N to 19.54’ degrees N and longitudes 77.14’degrees E to 81.47’ degrees E. Telangana is bounded in south by Rayalseema region of Andhra Pradesh, west by Karnataka, north and north-west by Maharashtra, north-east by Chhattisgarh and Orissa, east by Andhra (Circars) region of Andhra Pradesh. The total area of the State is 102173 sq km.

Geographically most of the Telangana is covered by the Western penneplains and partly with Eastern Ghats. The State’s interior plateau is formed with long belt of old penneplains (150- 600 m altitude) and is chiefly developed on the Archaean gneisses and granite rocks. The State has the best of Gondwanas with coal deposits that has been preserved along the lowest of Godavari trough. Majority of this is below 150m and most of the area is largely covered by deciduous forests.

2.1.1 Geology

A wide variety of geological formations like Dharwar schists, archaean or peninsular gneisses, purenas, Gondwanas and Deccan trap formations are found in Telangana. The Dharwar formations found in Mahbubnagar district are rich in minerals like mica, copper and gold. The rock formations are dominant with the Archaean or peninsular gneisses and contain granites, granodiorides and branded gneisses. The purenas are found in Adilabad, Mahbubnagar, Nalgonda and Ranga Reddy districts. These rocks include limestones, sand stones, slates and shales. The main repository of Gondwanas is the Pranahita and Godavari rivers alongside the eastern margin of Telangana. The upper Gondwanas along Godavari trough in eastern Adilabad and Karimnagar districts consists of mostly sandstones and shales. The coal seams are rich in lower Gondwana and are being mined at Kothagudem and Yellandu in Khammam district, Bellampalli in Adilabad district and Godavari Khani in Karimnagar district. The Deccan trap formations are composed of mostly greenish basaltic rocks, with occasional limestone beds interbedded with the basalt and are found in the western part of the region. The laterites occur as caps over Deccan traps in western Telangana.

There are different types of soils found in the Telangana, like, red soils, black soils, deltaic alluvial soils and laterite soils. Red soils are derived from gneisses and granite and they are poor in nitrogen content and plant nutrients but low to medium in available phosphates and medium to low in potash. These soils are poor in moisture
holding capacity and occupy majority of the area in the region. Deep and medium black soils also known as black cotton soils are found in the region, rich in calcium and potash but poor in nitrogen. The deep black soils are found on 10- 16 km. either side of the Pranahita, the Godavari and the Krishna rivers of the region. The light black soils are formed from Deccan trap rocks, found in Adilabad, Ranga Reddy, Medak and Nizamabad districts. The most fertile deltaic alluvial soils are found in the deltas of Krishna and Godavari. Laterite soils are found in Medak and Hyderabad districts. The composition of gneisses formation laterite soils vary from deep reddish to brown or black. These type of soils are found in Medak and Hyderabad districts.

2.1.2 Rivers

The Telangana is covered by the basins of two rivers the Godavari and the Krishna. The river Godavari is the second biggest river in the country and the largest river in South India. It originates in the Western Ghats at Triambak near Nasik in Maharashtra state, passes through Telangana, Madhya Pradesh, Orissa, and Andhra Pradesh, and falls in to Bay of Bengal near Yanam and Antarvedi in East Godavari district of Andhra Pradesh. The Godavari river enters the Telangana near Basar village of Adilabad district, flows through Nizamabad, Karimnagar, Warangal and Khammam districts. The total length of the river is 1584 km and its total catchment area is 312812 sq km spread in the six states. The river receives much of its water from its tributaries, namely, the Kadam, the Pranahita, the Manjira, the Penganga, the Manair, the Wardha, the Wainganga and the Sabari, the Indravathi and the Purana.

Krishna river, second after Godavari in southern India, originates about 64kms from the Arabian Sea in the western Ghats, north of the hill station of Mahabaleshwar in Maharashtra state, passes through Karnataka, Telangana and Andhra Pradesh, and falls in to Bay of Bengal between Hamsala Deevi and Nachakunta in Andhra Pradesh. This river enters the State near Tangadigi village in Mahbubnagar district. The total length of the river is 1400 km with a total catchment area of 258,938 sq km in three states. The important tributaries of river Krishna are Tungabhadra, the Bhima, the Dindi, the Wyra, the Chandravanka, the Tammileru, the Naguleru, the Hundri and the Musi.
2.1.3 Forest types

The vegetation types met in the Telangana is chiefly of southern tropical dry and moist deciduous type (Champion and Seth, 1968). The district-wise forest cover of Telangana is provided in Table 2.1.3a. The broad vegetation pattern of the Telangana is depicted in Fig. 2.1.1b. Of the total geographic area of Telangana State, 19.16 percent of area is covered by forests. Maximum forest cover is in the districts of Khammam (43.23 percent), followed by Adilabad (37.61 percent), Warangal (23.88 percent) and Nizamabad (15.03 percent). Least amount of forest cover was in Nalgonda (1.08 percent), followed by Hyderabad and Ranga Reddy districts (5.07 percent). The district of Mahbubnagar has 10.53 percent of its geographical area covered with forests, while the district of Medak has 6.03 percent of its geographic area covered with forests. Only three districts, namely, Adilabad, Khammam and Mahbubnagar have very dense forest cover covering an expanse of 484 sq km area. Moderately dense forest covers an area of 13,062 sq km, and is found in nine districts of state excepting the district of Hyderabad. Open forests cover an area of 8,464 sq km and is seen throughout all the ten districts of the State.

Table 2.1.3a. District-wise forest cover in Telangana (Data source: India State of Forest Report, 2011)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>District</th>
<th>Area (sq km)</th>
<th>Area covered by forest (in sq km)</th>
<th>Total</th>
<th>Scrub</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Very Dense</td>
<td>Moderately Dense</td>
<td>Open</td>
</tr>
<tr>
<td>1</td>
<td>Adilabad</td>
<td>16,128</td>
<td>127</td>
<td>3,643</td>
<td>2,296</td>
</tr>
<tr>
<td>2</td>
<td>Hyderabad &amp; Ranga Reddy</td>
<td>7,710</td>
<td>0</td>
<td>47</td>
<td>344</td>
</tr>
<tr>
<td>3</td>
<td>Karimnagar</td>
<td>11,823</td>
<td>0</td>
<td>979</td>
<td>699</td>
</tr>
<tr>
<td>4</td>
<td>Khammam</td>
<td>16,029</td>
<td>28</td>
<td>5,120</td>
<td>1,782</td>
</tr>
<tr>
<td>5</td>
<td>Mahbubnagar</td>
<td>18,432</td>
<td>329</td>
<td>537</td>
<td>1,076</td>
</tr>
<tr>
<td>6</td>
<td>Medak</td>
<td>9,700</td>
<td>0</td>
<td>81</td>
<td>504</td>
</tr>
<tr>
<td>7</td>
<td>Nalgonda</td>
<td>14,240</td>
<td>0</td>
<td>12</td>
<td>142</td>
</tr>
<tr>
<td>8</td>
<td>Nizamabad</td>
<td>7,956</td>
<td>0</td>
<td>217</td>
<td>979</td>
</tr>
<tr>
<td>9</td>
<td>Warangal</td>
<td>12,847</td>
<td>0</td>
<td>2,426</td>
<td>642</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,14,865</strong></td>
<td><strong>484</strong></td>
<td><strong>13,062</strong></td>
<td><strong>8,464</strong></td>
<td><strong>22,010</strong></td>
</tr>
</tbody>
</table>
Fig. 2.1.1b. Map depicting vegetation pattern of Telangana


A total of thirteen protected areas are recognized in Telangana (Table 2.1.3b), including two tiger reserves, three national parks and eight wildlife sanctuaries.

2.1.4 Climate

The Telangana is a part of the semi-arid region of the peninsular India with a typical tropical climate of hot summers (March to June) when the average temperature ranges from 20°C to 41°C. During these months the humidity is also recorded from normal to high. The region experience relatively pleasant winters (November to February) when average temperature ranges between 12°C to 30°C. The temperature in general ranges between 12°C recorded in Paloncha North Division to 50°C recorded in Kothagudem Division and the precipitation ranges between 700mm to 1302mm, the highest precipitation is recorded in the Bhadrachalam Division.
2.2 METHODOLOGY

2.2.1 Methods to study snakes

Even though a number of techniques are available, finding snakes in the nature is a skill developed through experience. To develop the ability of finding snakes in the field, number of factors should be considered one among them is careful observation. As snakes are often cryptic in their nature by means of colour and behaviour it is very difficult to find in them in their natural habitat. The present study was conducted from April 2009 to March 2013.

2.2.1.1 Collections (Live Snakes)

I explored various types of habitats where snakes can be found to collect the live snakes throughout the ten districts of Telangana (Fig. 2.2.1a). For collecting the live specimen, I explored all various types of natural habitats, practically in all possible places, where usually snakes can be found such as, termite mounds, ruined houses, rat burrows, hollows of the tree trunks, dead tree bark and logs, underneath the rocks, cracks and crevices, etc. to detect snakes. Snakes can be easily detected both during the early morning and late evening hours, when they are more active and are in search of food. For detecting nocturnal species, nigh surveys were also conducted. Keeping in view the variability in their activities according to the species of snake and time of the season, necessary care was taken to increase detectability. During the cooler months and also during the rains the snakes could be easily encountered as they are often encountered during the early noon, basking on rocks or such substrata. During summer they dwell in and around the humid places and become active by late evening. These timings are the best for their collection.

Many snakes were collected from the urban areas and human habitats. This is due to the reason that the snake has already been detected (in some cases also killed, by the time we reach the snake) and many people call volunteers to catch snakes from their garden or house or their nearby area. Freshly killed snakes have also been collected on the roads (Fig. 2.2.1b). On many occasions, aquatic snakes have been collected either from
the waterbody, such as slow-moving stream, lake, pond or a well, or from the fringes of such habitats.

Table 2.1.3b. Protected Areas in Telangana (Data source: Andhra Pradesh Forest Department, 2014)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the Protected Area</th>
<th>Designation</th>
<th>Area in Sq Km</th>
<th>Location (Districts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kawal</td>
<td>Tiger Reserve</td>
<td>893.0</td>
<td>Adilabad</td>
</tr>
<tr>
<td>2</td>
<td>Etumagaram</td>
<td>Wildlife Sanctuary</td>
<td>803.0</td>
<td>Warangal</td>
</tr>
<tr>
<td>3</td>
<td>Pakhal</td>
<td>Wildlife Sanctuary</td>
<td>879.3</td>
<td>Warangal</td>
</tr>
<tr>
<td>4</td>
<td>Pocharam</td>
<td>Wildlife Sanctuary</td>
<td>130.0</td>
<td>Medak &amp; Nizamabad</td>
</tr>
<tr>
<td>5</td>
<td>Kinnerasani</td>
<td>Wildlife Sanctuary</td>
<td>655.4</td>
<td>Khammam</td>
</tr>
<tr>
<td>6</td>
<td>Papikonda</td>
<td>Wildlife Sanctuary</td>
<td>590.7</td>
<td>Khammam (in Telangana State), East and West Godavari (in Andhra Pradesh State)</td>
</tr>
<tr>
<td>7</td>
<td>Nagarjunasagar-Srisailam</td>
<td>Tiger Reserve</td>
<td>3568.7</td>
<td>Mahbubnagar &amp; Nalgonda (in Telangana State), and Guntur, Prakasam &amp; Kurnool (in Andhra Pradesh State)</td>
</tr>
<tr>
<td>8</td>
<td>Pranahita</td>
<td>Wildlife Sanctuary</td>
<td>136.0</td>
<td>Adilabad</td>
</tr>
<tr>
<td>9</td>
<td>Siwaram</td>
<td>Wildlife Sanctuary</td>
<td>36.3</td>
<td>Adilabad &amp; Karimnagar</td>
</tr>
<tr>
<td>10</td>
<td>Kasu Brahmananda Reddy</td>
<td>National Park</td>
<td>1.5</td>
<td>Hyderabad</td>
</tr>
<tr>
<td>11</td>
<td>Mrugvani</td>
<td>National Park</td>
<td>3.6</td>
<td>Ranga Reddy</td>
</tr>
<tr>
<td>12</td>
<td>Mahaveer Harina Vanasthali</td>
<td>National Park</td>
<td>14.6</td>
<td>Hyderabad</td>
</tr>
<tr>
<td>13</td>
<td>Manjeera</td>
<td>Wildlife Sanctuary</td>
<td>20.0</td>
<td>Medak</td>
</tr>
</tbody>
</table>
Fig. 2.2.1a. Map of Telangana depicting ten districts where the study was conducted

Fig. 2.2.1b. Road kills of snakes were also important source of information on snake presence in any given area
Depending on the type of the snake being dealt with, varieties of snake handling and capturing techniques have been incorporated during the study. Although many types of snake sticks (Fig. 2.2.1c) are available, I have used the ‘hook-shaped’ snake stick for catching and handling snakes (Fig. 2.2.1d). If the snake was sighted under a thorny bush or unreachable place, it was pulled out in open by a snake stick. Depending on whether the snake is large one or not, handling style varied. If the snake was a large one (more than a meter long), it is held by the tail because, this leaves a hope for the snake to escape as its half to two third of the body length still touches the ground. After pinning the head with handle-end of the stick, the tail was gently and firmly held at the neck by other hand with thumb and fore fingers and then lifted. Care was taken in getting a grip just behind the skull, so that it does not form a loop of its body near the neck region to bite. After getting the firm grip, the tail is handled with other hand and the snake is lifted in air. Large specimens usually coil around the arm, cause pressure and try to escape by loosening the grip. After the catching, the snake is carefully placed in a specially prepared cotton bag with the help of the assistance (Fig. 2.2.1d). For placing the snake in the bag, first the tail is dropped gently and carefully into the cotton bag as it is held open by the assistant and then the snake’s head is taken near the mouth of the bag and dropped into the bag and the mouth is closed quickly to ensure that the snake does not try to escape. The mouth of the bag is tied and the bag is tagged properly with required label.

Fig. 2.2.1c. Types of snake sticks that are used in catching and handling snakes; A: L-shaped stick, B: Y-shaped stick and C: J-shaped stick
Smaller snakes (usually less than a meter long) are pulled out from the bushes/hedges in to the open by a stick. After pinning the head with the stick, holding carefully the neck by other hand with thumb and fore fingers, the snakes are picked up and kept in a bag. Long forceps are used to collect very small snakes (less than 40 cm long). Care is taken to avoid accidents while handling poisonous snakes, both to the handler and the snake.

As snakes are very sensitive to vibrations perceived through their ventral body surface, care was taken to not to cause unnecessary disturbances while surveying to enhance observation and collection.

![Fig. 2.2.1d. J-shaped snake stick and collection bag used during the study](image)

After a snake is caught, the meristic and scalation data is collected and recorded in the data-sheet. When a dead specimen is encountered or a few vouchers were collected, the preservation was done using standard protocols. The vouchers are preserved in 10% formaldehyde solution in glass containers and deposited in the collection of the Natural History Museum of the Osmania University, Hyderabad.
2.2.1.2 Data from preserved snakes

The Natural History Museum of the Osmania University, Hyderabad and the Freshwater Biology Station of Zoological Survey of India, Hyderabad have a few preserved specimens of snakes collected from the Telangana, I have studied the snake collections therein and noted the required data of snake specimens.

2.2.1.3 Data from snakes rescued from Hyderabad

The volunteers of the Friends of Snakes Society, an NGO involved in snake rescue and education, rescue and temporarily hold specimens of snakes from the city limits of Hyderabad. These collections also are important source of information and I have studied a few rare snake species collected by them.

2.2.1.4 Preservation

A few voucher specimens were collected and preserved for future reference. The snake specimens were sacrificed using chloroform and preserved in glass containers of required sizes. The containers were labelled with family, genus, species, date of collection, locality and other important notes if any and deposited in the Natural History Museum of Osmania University, Hyderabad. The snake specimens were preserved in 10% formaldehyde solution. For better preservation 10% formaldehyde was injected in to the body, and sometimes three to five ventral cuts of 3 cm long were made on the body for preservative to seep in and also preserve the internal organs. Some small specimens were preserved in 70% ethyl alcohol.

2.2.2 Snake identification

Squamation or scalation is often most important tool for snake identification. This is one of the principal features that is used in identification and is very often the principal component of identification keys. Some of the important characteristics with respect to scalation are:
I. General body scalation: In the blind burrowing snakes, the body is covered by smooth cycloid scales arranged in an alternating pattern of both longitudinal and transverse rows, and there are no enlarged ventral scutes. In most of the other snakes the abdominal region is covered by a series of greatly expanded ventral scutes so that the dorsal squamation and ventral squamation are distinct.

II. Head scalation: The size, shape and arrangement of the head scales or shields are of great importance for identifying snakes. Fossorial and burrowing snakes have the upper and lateral surfaces of the head covered by enlarged, smooth shiny scales that may or may not be same like the dorsal scales. In some snakes the upper head surface is covered with many small scales that are about the same size as the dorsal scales, sometimes they might be keeled (usually medially) or smooth. The supralabials and infralabials series consists of enlarged symmetrical shields. Some species, like the colubrids, have large smooth symmetrical head shields, while some forms, like viperids, have a mixture of enlarged shields and small smooth or keeled scales on the upper head surface. In most taxa with symmetrical shields the arrangement is very constant.

![Fig. 2.2.2a. Thermoreceptors lodged in distinct and visible pits on supralabials in Python molurus](image)

The throat region also allows differentiation in scales features. In some snakes, the gular area is covered with small scales like those on the body. In others, a definite mental groove runs down the midline of the throat and usually is bordered laterally by one or two pairs of enlarged chin (genial) shields.
**Other head specializations:** The supralabials of the python characteristically possess a series of thermoreceptors lodged in distinct and visible pits (Fig. 2.2.2a). A single large loreal pit lies between the eye and nostril on the lateral surface of the head in bamboo pit viper.

**III. Dorsal scalation:** Dorsal scales, also known as dorsals or costals, are present on the dorsal and lateral sides of the body. They are arranged in longitudinal rows and the number of rows is definite for the species. The rows of scales on the body are counted from the left side to the mid-dorsal in ascending order and further upto the right lateral side in descending order (Fig. 2.2.2b). The first scale is the scale just on the edge of ventral one and the same way the last one. The dorsal scales are of various types such as, unkeeled or smooth, keeled, feebly keeled, oblique in shape, serrated keeled, hexagonal, squarish and centrally tubercled.

![Fig. 2.2.2b. Body scales (numbers indicate best method for counting body scales) V: Ventrals](image)

**IV. Ventral scalation:** Ventral scales, also known as ventrals, are present on the ventral side of the body. The first ventral starts from the neck and the last ventral is just anterior to the anal plate. The ventral scales are semicircular or imbricate (uniform) as in Typhlopidae, Leptotyphlopidae and Hydrophinae. Ventral scales are less enlarged and not across the width of belly are found in members of the families Uropeltidae and Boidae and well-developed entire across belly are commonly found in the members of advanced families.
Scales on the ventral side of the tail are called as subcaudal scales. The subcaudals may be divided or undivided (Fig. 2.2.2c). Anus or vent is covered with anal plate, which is either single or divided into two (Fig. 2.2.2d).

Fig. 2.2.2c. Diagram showing caudal scales A: undivided caudal scales B: divided caudal scales

Fig. 2.2.2d. Diagram showing anal plate A: divided anal plate B: undivided anal plate
V. Body shape: It is easy to identify some families of snakes from the stout body and short tail. Viperids are always with triangular head, thin neck and a tapering tail. *Ahaetulla* (vine snake) species have a pointed beak-like head and very long thin slender body. Terrestrial snakes have round slender long or moderate tail, while true aquatic snakes (like the sea snakes) have strongly laterally compressed paddle-shaped tail.

2.2.3 Diversity Indices

Species richness is one of the many diversity analyses focuses on diversity at species level, and is most widely used method to evaluate (alpha= diversity within study area) diversity. Species richness was studied using various indices, such as, the Simpson's Index, the Dominance Index, the Shannon's Index and the Equitability Index. The effective number of species was also calculated. The richness analysis of species is considered as a key measurement for analyzing the conservation needs (Frankel *et al.*, 1995; Petit *et al.*, 1998; Scheldeman *et al.*, 2010). Such conservation efforts will greatly benefit from information on the distribution and diversity of the genus.

2.2.4 Mapping

DIVA-GIS (ver. 7.5) is an open source software developed by Robert Hijmans. Maps on the spatial distribution pattern were generated with the help of DIVA-GIS.

2.2.5 Species Distribution Modeling

Maps predicting habitat suitability across Telangana for 25 of the 29 species were generated using MaxEnt Species Distribution Modelling software version 3·3·3k (Phillips, *et al.*, 2006). The remaining 4 species were not modelled because they occurred in just one locality with one record. In these cases, we assumed that these species are present only in the cells where they were recorded. MaxEnt method was selected because it is considered one of the most accurate when only presence information is available, and it outperforms other, more conventional methods that use presence–absence information (Elith *et al.*, 2006).
MaxEnt software for species habitat modelling is a machine-learning algorithm following the principles of maximum-entropy approach for species habitat modelling. This software takes as input a set of layers or environmental variables (such as elevation, precipitation, etc.), as well as a set of georeferenced occurrence locations (observed distribution points), and produces a model of the range of the given species (where the species could potentially occur) (Steven et al., 2004, 2006; Elith et al., 2011).

The results produced by MaxEnt were interpreted as follows:

- **Gain**: The gain is closely related to deviance, a measure of goodness of fit. The higher the gain, the more discriminative the predicted distribution for species’ occurrence is in comparison to a random distribution. For example, if the gain is two (2), it indicates that the average likelihood of the presence samples is $\exp(2) \approx 7.4$ times higher than that of a random background pixel (Philips, 2009).

- **AUC**: One of the parameters used for evaluating the predictive ability of the models generated by MaxEnt is the Area Under Curve (AUC) of the Receiver Operating Characteristic (ROC) curve. The AUC is equal to the likelihood that a randomly selected presence point is located in a raster cell with a higher probability value for species occurrence than a randomly selected absence point. Species distribution modelling in this manual includes presence points only. To still be able to calculate the AUC, MaxEnt replaces absence points with randomly generated points from the study area. The AUC can then be interpreted as the likelihood that a randomly selected presence point is located in a raster cell with a higher probability value for species occurrence than a randomly generated point (Phillips et al., 2006).

The fractional predicted area on the X-axis of the AUC graph is the fraction of the total study area where the species is predicted present, while the sensitivity on the Y-axis is the proportion of presence points in the modeled area of occurrence on the total number of actual presence points. The highest predictive power of a model generated by MaxEnt is reached when the AUC has a value of 1. In practice, no AUC will be lower than 0.5, which is similar to Random prediction. In that case MaxEnt has no predictive power at all. Araújo et al. (2005) recommend the following interpretation of AUC for the models generated:
Excellent if AUC>0.90; Good if 0.80>AUC≤0.90; Acceptable if 0.70>AUC≤0.80; Bad if 0.60>AUC≤0.70; Invalid if 0.50>AUC≤0.60. If the predicted area is low in comparison to the study area, high AUC values doesn’t necessarily reflect good model performance, and simply could be an artefact of the AUC statistic (Fawcett, 2006; Philips, 2009).

**BioClim:** The climate data set was downloaded from the DIVA-GIS homepage (http://www.diva-gis.org). Bioclimatic variables of WorldClim (Hijmans et al., 2005) are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. The bioclimatic variables represent annual trends (e.g., mean annual temperature, annual precipitation) seasonality (e.g., annual range in temperature and precipitation) and extreme or limiting environmental factors (e.g., temperature of the coldest and warmest month, and precipitation of the wet and dry quarters). A quarter is a period of three months (1/4 of the year). Environmental variables from WorldClim dataset (Hijmans et al., 2005) were extracted for Telangana and used for prediction to get precise results.

Bioclimatic variables used in DIVA-GIS and MaxEnt models from WorldClim datasets are coded as follows: Annual Mean Temperature (BIO1); Mean Diurnal Range (Mean of monthly (max temp - min temp)) (BIO2); Isothermality (BIO2/BIO7) (* 100) (BIO3); Temperature Seasonality (standard deviation *100) (BIO4); Max Temperature of Warmest Month (BIO5); Min Temperature of Coldest Month (BIO6); Temperature Annual Range (BIO5-BIO6) (BIO7); Mean Temperature of Wettest Quarter (BIO8); Mean Temperature of Driest Quarter (BIO9); Mean Temperature of Warmest Quarter (BIO10); Mean Temperature of Coldest Quarter (BIO11); Annual Precipitation (BIO12); Precipitation of Wettest Month (BIO13); Precipitation of Driest Month (BIO14); Precipitation Seasonality (Coefficient of Variation) (BIO15); Precipitation of Wettest Quarter (BIO16); Precipitation of Driest Quarter (BIO17); Precipitation of Warmest Quarter (BIO18); Precipitation of Coldest Quarter (BIO19); and Altitude (ALT).