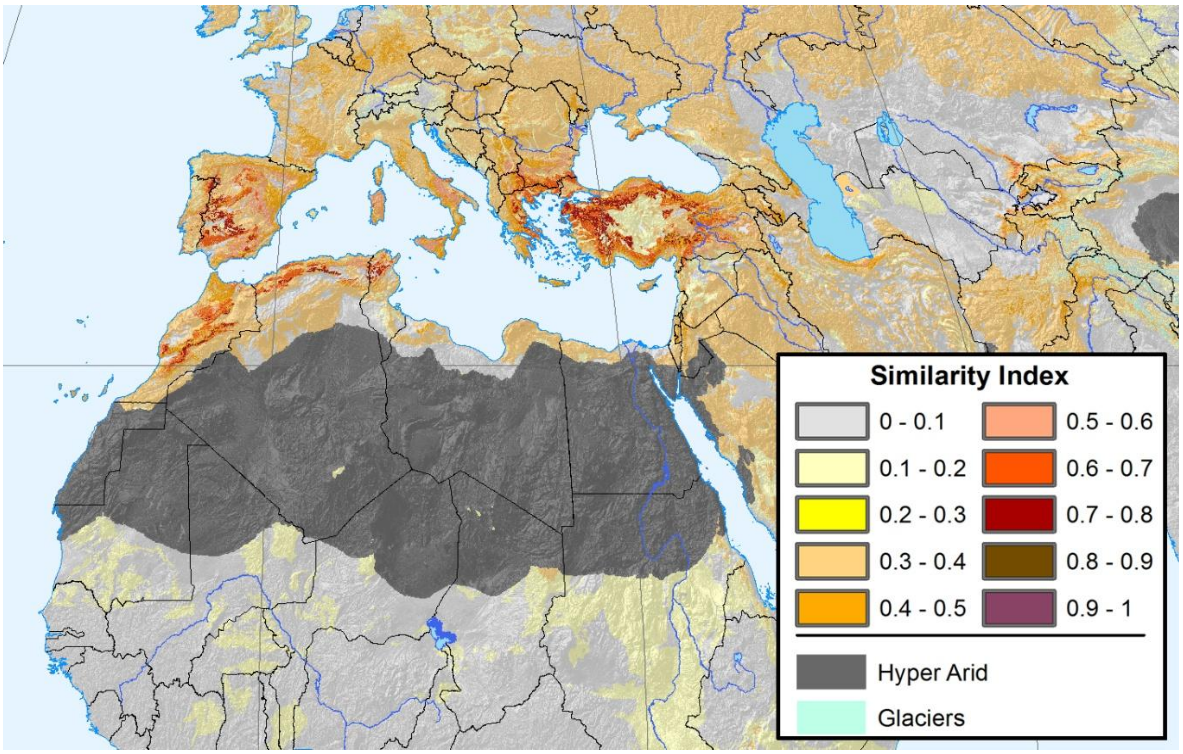
USE OF GIS TOOLS FOR THE INTEGRATION OF PRODUCTION ENVIRONMENT DESCRIPTORS OF ANIMAL GENETIC RESOURCES



E. De Pauw, B. Rischkowsky, A. Abou-Naga, H.R. Ansari-Renani, I. Boujenane, O. Gursoy

Final Report of Project "Practical Application of Production Environment Descriptors for Animal Genetic Resources – country case studies for sheep and goat breeds"
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Front cover: the map shows similarity in the natural environment of parts of Europe, Africa and Asia with the distribution area of the Turkish Dagliç sheep breed.

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1. INTRODUCTION

Improved understanding of the adaptation of livestock breeds to their production environments is important for many decisions in the field of animal genetic resources (AnGR) management. However, adaptation is complex and difficult to measure. One approach is to characterize adaptation indirectly by describing the production environments in which a breed has been kept over time, and to which it has probably become adapted. Comprehensive and comparable descriptions of the production environments in which animals are kept are also vital to make meaningful evaluations of performance data and to enable comparative analysis of the performance of different breeds.

To address the requirement of defining production environments, FAO has proposed that a recognized set of "production environment descriptors" (PEDs) should be established and used throughout the world as a common framework for describing breeds' production environments.
An expert workshop on Production Environment Descriptors for Animal Genetic Resources (FAO/WAAP, 2008), held in 2008 (shorthand: PEDS Workshop) completed the framework and proposed a set of PEDS. The workshop concluded that descriptors for the natural environment can be best obtained by mapping the location of the breed and linking this to existing GIS-based datasets; and that the management environment descriptors should be collected by a standard set of questions about each breed describing the management conditions in which the breed is kept. Accordingly questionnaires were developed to collect relevant data on management, production systems and breed characteristics.

Based on the outcomes of the workshop the FAO team has been developing a PEDs module for the Domestic Animal Diversity Information System (DAD-IS; http://dad.fao.org/) hosted by FAO. DAD-IS is a global information system and serves as a communication and information tool for the management of animal genetic resources (AnGR). It provides the user with searchable databases of breed-related information and images, management tools, and a library of references, links and contacts of Regional and National Coordinators for the Management of AnGR. It provides countries with a secure means to control the entry, updating and accessing of their national data, a forum for exchange of ideas and techniques; country, regional and global contacts; and a repository for documents related to the management of AnGR. The new PEDS module in DAD-IS is supposed to allow the National Coordinators (NCs)[1] to enter the description of the production environments and special characteristics related to adaptation for the breeds in their countries. A mapping tool will allow them to enter spatial data.

There are several challenges to the proposed approach:

- the degree of knowledge on production environments to be expected from National Coordinators or other national AnGR experts in the countries;
- ease of collecting information on breed distributions of all species;
- availability and accessibility of GIS referenced datasets on the natural environment once the breed distribution has been captured.

To address these challenges and to practically test the PEDs approach, FAO and ICARDA initiated a pilot study in 2010 with sheep and goat breeds in four countries.

The specific objectives of the projects included:

[1] NCs are appointed officially by the Ministry of Agriculture and form FAO's international network for the management of AnGR.

- developing a data capturing tool following the questionnaire included in the report of the PEDS workshop and transferring the data collected for sheep and goat breeds in the four selected countries
- developing methodologies such as similarity mapping and agro-ecological zoning (ICARDA methodology) for aggregating the PEDs and arrive at predictions of adaptive traits of breeds
- comparing the analytic results from the GIS layers describing the natural environment currently being made available at global scale for DAD-IS with the GIS layers available at ICARDA.

A new DAD-IS module enabling capturing of data related to production environments in which certain portions of breed populations are kept was supposed to be finalized and launched by FAO in mid 2010 and then tested and used by ICARDA. Due to a delay in the finalization and launching of the new module by FAO, ICARDA was unable to collect and capture the pilot data using the DAD-IS module as agreed. Instead, FAO requested ICARDA to develop a data capturing system in order to implement the other elements of the LoA.

Thus the final agreed outputs from this project were:

- improved GIS data of goat and sheep breed distribution for four countries, namely Egypt, Iran, Morocco and Turkey, entered in DAD-IS,
- a methodology for aggregating individual production environment descriptors to enable automated overviews of AnGR diversity by production environment in DAD-IS,
- a comparison of results from some environmental spatial datasets to be used in DAD-IS with higher-resolution spatial data available at ICARDA.
- a final report including the breed distribution maps for the above named countries and maps of aggregated PEDs at country and at global scale.

2. METHODOLOGY

2.1. SELECTION OF COUNTRIES/BREEDS FOR THE PILOT STUDY

Egypt, Iran, Morocco, and Turkey were selected as pilot countries they contain a diverse mix of goat and sheep breeds and of agro-ecological zones in non-tropical dry areas. Furthermore, these countries had been included in the characterization of sheep and goat breeds carried out by ICARDA in West Asia and North Africa (Iñiguez, 2005).

For our study we contacted NARs scientists in the four countries that had collaborated with ICARDA in the previous characterization studies. The collaborators for our study were:

- Egypt: Dr. Adel Abou-Naga[2], Animal Production Science Research Institute, Cairo
- Iran: Dr. M.A. Abbasi and Dr. Hamid Reza Ansari-Renani[3], Animal Science Research Institute, Karaj
- Morocco: Dr. Ismail Boujenane[4], Institut Agronomique et Vétérinaire Hassan II, Rabat
- Turkey: Prof. Dr. OktayGursoy, Çukurova University, Adana

The project was explained and discussed in detail with the national collaborators during visits in Iran, Egypt and Turkey and with Dr. Boujenane by email. The collaborators were informed that at the end of the project all information would be shared with FAO and the National Coordinators. The partners from Turkey and Morocco were provided with the contact details of the National Coordinators.

Then the lists of local sheep and goat breeds were agreed upon for the four countries. Clearly distinct local/indigenous breeds or already well-established crossbred/synthetic breeds such as the Anatolian Merino in Turkey that have been adopted and are spread among producers were included. International trans-boundary breeds present in the countries were excluded because their distribution is not determined by adaptation to the natural environment but rather by the presence of more intensive production systems or a research/development program. Thus, mapping their distribution would not have added value to this study .An exception was made for the Awassi breed because of its high regional importance. In total 61 sheep and 24 goat breeds were included (Table 1).

Table 1. Number of sheep and goat breeds included in the study

Species	Morocco	Egypt	Turkey	Iran	Total
Sheep breeds	6*	8	20	27	61
Goat breeds	4	7	6	7	24
Total	**10**	**15**	**26**	**34**	**85**

*For 5 sheep breeds in addition to the current geographical distribution their origins were mapped.

A short description of the included breeds was provided in the Annex tables of the first progress report. In April 2011 the breeds included in the current study were compared with the breed entries (inventory)

[2]Dr.Abou Naga was officially nominated as National Coordinator for AnGR in Egypt end of 2010.
[3]Dr.Abbasi was appointed by Dr.Kamali, the NC of Iran, to represent him in this project, but the data and maps were submitted by Dr. Hamid Reza Ansari-Renani, another scientist from the same institute.
[4]Dr.Boujenane and Prof.Gursoy were authors of the respective country book chapters in the Characterization of small ruminant breeds in West Asia and North Africa (Iñiguez, 2005).

in DAD-IS; the direct link to the breed entry in DAD-IS IS was added to the tables and sent to FAO. The comparison of breeds listed for this project with DAD-IS entries was based on ICARDA's book series on small ruminant (SR) breed characterization and the knowledge of our collaborators. It revealed that a number of breed entries in DAD-IS should be corrected and some removed:

- for some breeds there was no other information besides the names in DAD-IS and they were not known to our collaborators. They are probably varieties of another breed with no clear description;
- some breeds are listed twice in DAD-IS under slightly different names but are definitely the same breeds.

In the case of Egypt and Iran the information was fed back to the NCs. It is proposed that FAO would share the DAD-IS tables in which we marked the questionable breeds with the National Coordinators in Morocco and Turkey. In particular, Morocco would need a serious update as there are many breeds listed in DAD-IS without any information and it is not clear if these breeds still exist or have ever been present in the country. Maybe here and in other countries information from the country report was added that was not relevant or accurate.

2.2. MAPPING THE GEOGRAPHICAL DISTRIBUTION OF THE BREEDS

FAO's mapping tool was not ready in time to be used and tested in this project. Instead ICARDA's GIS Unit scanned detailed road maps of the countries and sent them electronically and as hard copies to the collaborators.
The collaborator from Iran used the electronic copy of the map and a paint program to draw the breed distributions and sent us the maps in electronic format. The other three collaborators preferred to draw the boundaries of the breed distributions in the hard copies of the maps and sent the hard copies back to ICARDA. Prof. Gursoy actually visited ICARDA in December 2010 and explained the borders of breed distribution for Turkey that he had demarcated on the maps directly to the ICARDA scientists. To illustrate the process of defining the breed domains, an example of a 'raw' breed distribution map (for sheep in Western Turkey) was sent to FAO together with the first progress report.
In Egypt the breed distributions were mapped by the NC using the boundaries of the Egyptian agro-ecological zones in which they occur.

The breed distribution maps for the four countries were digitized and converted into ESRI shapefiles and sent to FAO on a DVD. The digital distribution maps prepared by GISU were validated with the Egyptian collaborators during a meeting in April 2011 and the maps corrected accordingly by GISU.
Final maps of the individual breed distributions were prepared and are included on the DVD as Annex 3. Consolidated country maps for sheep and goat breeds are presented in figures 4 to 13.

2.3. OBTAINING ADDITIONAL MANAGEMENT DATA

As FAO's data entry mask in DAD-IS was not ready, the collaborators filled the questionnaires (word documents) as developed by the PEDS workshop. For each breed two questionnaires/worksheets, namely *Annex 4a. Production environment descriptors* and *Annex 4b: Worksheet for describing breeds' special qualities*, were filled. The information from the Word documents was transferred to an Excel sheet to allow an analysis of the available data. The Word documents are to be sent together with the maps to FAO. For Iran and Egypt this information could be directly entered into DAD-IS as our collaborators would have access to the country database in DAD-IS.

A major difficulty for all collaborators was to enter the required information on disease challenges and treatments as the collaborators are breeders. This may also be the case for the National Coordinators in other countries. To overcome this hurdle it would be useful to generate digital maps of disease prevalence (compare 4.2.1).

2.4. CHARACTERIZATION OF BREEDS, DISTRIBUTION AREAS AND MANAGEMENT FACTORS

2.4.1. Characterization of the selected breeds

A complete characterization of the selected breeds was carried out following the PEDS framework using indicators belonging to the following thematic areas:

- Length of time that the breed has been in its production environment
- Climate modifiers
- Feed and water availability and management
- Contribution by each feed type of dry matter fed to the animals in the vegetation period and outside the vegetation period, or throughout the year in case there is no specific vegetation period
- Main uses and roles of the breed in this production environment
- Breed characteristics relevant to climate
- Breed characteristics relevant to terrain
- Breed tolerance relevant to feed and water availability
- Special adaptation features
- Specific quality of products

The full database compiled on breed characterization in accordance with the PEDS framework is included as an Excel spreadsheet.

2.4.2. Characterization of the distribution areas

Prior to the implementation of the PEDS module, DAD-IS did not contain a template for the detailed description of the natural environment. Lack of a structured description template forced the National Coordinators or their representatives into very general non-standardized descriptions or narratives of the natural environment.

The PEDS module currently contains descriptors for the natural environment related to :

- climate (temperature, precipitation, relative humidity, wind, daylength, solar radiation)
- terrain (altitude, slope, soil pH, surface conditions)
- diseases, parasites and other animal health threats

These descriptors are not yet available for data-entry in DAD-IS, but once they are, may help to characterize the breed natural environments more accurately. A disadvantage of these descriptors is that they are basically *single-value descriptors*, in the sense that an average attribute value is to be assigned for the entire breed area. Therefore the *spatial variability* within the breed area, which can be very considerable, particularly if the breed area is very large and contains strong elevation or climatic gradients, is not taken into consideration. Yet the variability in the resource base within a breed area in space and time may be key to its adaptation. Moreover there is a high risk of errors in these averages, as true area averages can only be obtained from knowledge of the attribute values in individual locations. It is precisely in this respect that the use of spatial datasets in conjunction with GIS tools may allow more accurate assessments of the natural environments, particularly if up-to-date and reliable national databases are available and accessible.

Having no access to recent, quality-controlled national data the following international data sources were used for the characterization of the breed distribution areas in the four countries:

1) For climate:
De Pauw, E. 2008. Climatic and Soil Datasets for the ICARDA Wheat Genetic Resource Collections of the Eurasia Region. Explanatory Notes. ICARDA GIS Unit, Aleppo, Syria.68 pages.
(http://geonet.icarda.cgiar.org/geonetwork/data/regional/GRU_NetBlotch/Doc/Report_NetBlotch.pdf).

2) For terrain:
SRTM30 Digital Elevation Model (http://topex.ucsd.edu/WWW_html/srtm30_plus.html)

3) For soils:
FAO-UNESCO.1995. The Digital Soil Map of the World and Derived Soil Properties. Land and Water Digital Media Series 1. FAO, Rome, CD-ROM.

4) For land use/land cover:
D. Celis, E. De Pauw and R. Geerken. 2007. Assessment of land cover/ land use in the CWANA region using AVHRR imagery and agro-climatic data. Part 1. Land Cover/Land Use - base year 1993. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria, vi+ 54 pp. ISBN 92-9127-192-4

5) For agro-ecological zones:
E. De Pauw. 2010. Agro-ecological zoning of the CWANA region. In A. El-Beltagy and M.C. Saxena (Eds.).Sustainable Development in Drylands – Meeting the Challenge of Global Climate Change. Proceedings of the Ninth International Conference on Development of Drylands, 7-10 November 2008, pp. 335-348, International Drylands Development Commission, ICARDA.
Map available for viewing on the ICARDA web site (http://www.icarda.cgiar.org/hps_11-03-27_WhatCanGrow.htm)

From these datasets the following attributes were derived for the characterization of the production environments of the selected breeds:

- Annual precipitation
- Agro-climatic zones
- Landforms
- Land use/land cover
- Soil Management domains
- Agro-ecological zones

Characterization in terms of the above themes was done by classification of each attribute into relevant classes and by tabulating the proportion of each class in each breed distribution area. The latter were obtained through the Zonal Histogram function of the Spatial Analyst module in ArcGIS software.

The description and classification of the characterization attributes of the breed distribution areas is provided in the following sections.

2.4.2.1. Annual precipitation

This is a GIS raster layer with spatial resolution of 30 arc-seconds (0.0083333 decimal degrees, or nearly 1 km in N-S direction) obtained by spatial interpolation of station-based climatic data. The interpolation method was the 'thin-plate smoothing spline' method of Hutchinson (1995), as implemented in the ANUSPLIN software (Hutchinson, 2000). The Hutchinson method is a smoothing interpolation technique that is guided by topography: the limited station precipitation data are extended across the entire grid by correlations with elevation. The latter was input to the model in the form of a DEM ASCII grid file. The DEM used to generate the climate surfaces was the SRTM30 DEM with 30 arc-second (approximately 1 km) resolution. The precipitation data are annual averages for different time periods, but with a minimum of 20 years in the case of precipitation. The main sources were international, such as the Food and Agriculture Organization of the United Nations and the National Climate Data Center of the US (NCDC). For Iran the data came mostly from national archives.

2.4.2.2. Agro-climatic zones

The *agro-climatic zones* are combinations of GIS raster layers related to moisture regime, and winter and summer temperature regimes, in accordance with the criteria and class thresholds as implemented in the UNESCO classification system for arid regions (UNESCO, 1979). The classes are shown in Tables 1-3.

Table 2. Classes for the moisture regime

Moisture regime	Hyper-arid (HA)	Arid (A)	Semi-arid (SA)	Sub-humid (SH)	Humid (H)	Per-humid (PH)
Aridity index	<0.03	0.03-0.2	0.2-0.5	0.5-0.75	0.75-1	>1

Table 3. Classes for the winter type

Winter type	Warm (W)	Mild (M)	Cool (C)	Cold (K)
Mean temp. coldest month	> 20°C	> 10°C	> 0°C	≤ 0°C

Table 4. Classes for the summer type

Summer type	Very warm (VW)	Warm (W)	Mild (M)	Cool (C)
Mean temp. warmest month	> 30°C	> 20°C	> 10°C	≤ 10°C

In this classification system the *moisture regime* is determined by the ratio of annual rainfall over annual potential evapotranspiration (also referred to as *aridity index*), calculated according to the Penman-method (Doorenbos and Pruitt, 1984).The potential evapotranspiration (PET) is a measure of the atmospheric water demand for a grass cover (and for crops by including crop coefficients).

The Aridity Index provides a waterbalance in its most elementary form (on annual basis) and takes account of higher moisture demand in hot climates, as well as differences in the effectiveness of precipitation for growth cycles that include a cold period versus those that do not (Table 2).
The *winter type* is determined by the mean temperature of the coldest month (Table 3).
The *summer type* is determined by the mean temperature of the warmest month (Table 4).

The UNESCO system is basically open-ended and any particular climate can be described by the three attributes, moisture regime, winter type and summer type. Despite its apparent simplicity the UNESCO system is capable of capturing the key characteristics of an agricultural climate of relevance for livestock: degree of aridity and temperature conditions in the warmest and coldest month of the year. For example, the climate *SA-C-VW* is characterized by a semi-arid moisture regime, a cool winter type and very warm summer type.

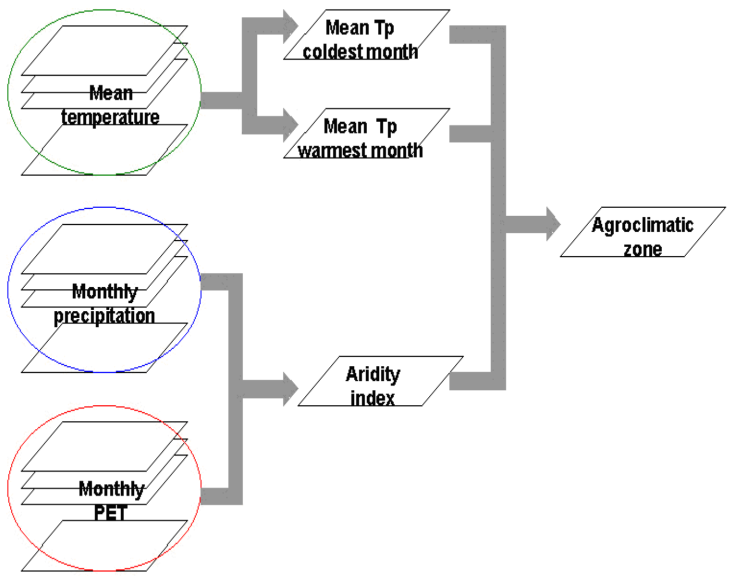

Figure 1. Developing the Agro-climatic Zones framework
(Tp: temperature)

Figure 1 outlines the combination of basic and derived climatic surfaces used to generate the Agro-climatic Zones.

2.4.2.3. Landforms

The most important attributes of topography relevant to livestock are the elevation and the slope. Due to the lapse of air temperature that takes place with increasing altitude, the effect of absolute elevation is basically a temperature effect, which is already accounted by the climatic classification explained in section 2.4.2.2. The slope obviously presents an accessibility effect that can be quantified using a high-resolution digital elevation model, for example by the proportions of a breed area in different slope classes. However, to get an overview over the large areas that most breeds occupy, a simple classification of landforms appears adequate.

Based on the SRTM30 digital elevation model (spatial resolution: 30 arc-seconds, 0.0083333 decimal degrees, or nearly 1 km in N-S direction) simplified landform classes were obtained using the following rules:

Plains: maximum elevation difference between neighboring pixels 0-50 m
Hills: maximum elevation difference between neighboring pixels 50-300 m
Mountains: maximum elevation difference between neighboring pixels > 300 m
The maximum elevation difference between neighboring pixels was calculated using the Range function in the Spatial Analyst module of Arctic software with subsequent classification.

2.4.2.4. Land use/land cover

Land use/land cover data for the breed distribution areas were extracted from the regional Land Use/Land Cover Map prepared by Celis et al. (2007) for the base year 1993. This is not the most up-to-date map in the public domain, but probably more reliable than other land cover maps from international sources, as it contains a limited number of classes and has been given considerable ground truthing:

- barren/sparsely vegetated
- irrigated crops
- rainfed crops
- rangelands
- forests
- other land uses/cover type (mainly urban, water bodies)

The distinction between rainfed and irrigated crops was considered relevant for livestock as irrigated areas usually produce higher yields, biomass and crop residues than rainfed areas, which are partially or entirely retained for livestock use.
The spatial resolution of this thematic layer is also 30 arc-seconds, or about 1 km in N-S direction.

2.4.2.5. Agro-ecological zones

Agro-ecological zones (AEZ) are the integrated spatial entities that emerge by the overlaying of agro-climatic zones, landforms, land use/land cover classes and soil patterns. The agro-ecological zones were generated by the following 6-step procedure:

- Converting point climatic data into basic climatic 'surfaces' through spatial interpolation;
- Generating a spatial framework of *agro-climatic zones* (ACZ) by combining the basic climatic surfaces into more integrated variables that provide a synthesis of climate conditions;
- Generating a spatial framework of *land systems*, which are integrated land-based mapping units, created by the combinations of major land use/land cover, landforms and soil categories;
- Integrating the frameworks for agro-climatic zones and land systems by overlaying in GIS;
- Removing redundancies, inconsistencies, and spurious mapping units generated by the overlaying process;
- Characterizing the AEZ in terms of other relevant themes (e.g. population density, land degradation, length of growing period etc.).

The full procedure and data sources are described by De Pauw (2010).
In order to avoid unnecessary complexity, in the current study we used as *agro-ecological zones* the integrated units formed by the overlaying of agro-climatic zones, landforms and land use/land cover, as described in the previous sections.
To define the AEZ in terms of land use/land cover, a further simplification was done, using only 3 classes (irrigated crops, rainfed crops and non-agricultural land use). The latter class is a very diverse one, as it may contain grasslands, open or closed shrublands as well as barren/sparsely vegetated land. However, the regrouping of the land use/land cover classes into broader classes avoids repeating what is already known from the land use/land cover characterization, as described in section 2.4.2.1.

Section 3.3.3 contains the list of AEZs that occur in the breed distribution areas, as well as their short descriptions.

2.4.2.6. Soil management domains

In the PEDS description module, soil pH is listed as a terrain attribute. Whereas certain soil characteristics (e.g. stoniness, sandy texture, wetness) undoubtedly influence terrain and its accessibility, these and other soil features (e.g. strong acidity, salinity, sodicity, flooding, water logging) may also act as proxies for vegetation communities. Thus soils and their management properties may acquire implicit or explicit significance in terms of the vegetation communities they support, with their own characteristics of palatability and nutrient status, or the physical or chemical constraints they impose on plant development.

Soil management domains can be defined as combinations of soil types that have been merged into broader groupings that are relevant to such key management properties.

The soil management domains were defined and mapped as part of an ICARDA project on agro-ecological zoning of the CWANA region (covering North Africa, the Horn of Africa, West and Central Asia) and the methodology is described by De Pauw (2010). Using the FAO Soil Map of the World (FAO, 1995) as data source, it was found that within the CWANA region 1047 soil associations occur, as determined by varying combinations of 112 FAO soil types. Reducing this vast variability by regrouping was necessary in order to establish ecosystems that were not over-fragmented. This generalization was done in two steps:

1) regrouping the FAO soil types into broader classes that are relevant to their general management properties ('soil management groups')
2) mapping the major combinations of these soil management groups ('soil management domains')

The 126 FAO soil units were reduced to 13 soil management groups as indicated in Table 5.

Table 5. Conversion of FAO soil types into new soil management groups

SMG	**Soil Management Group**	**FAO soil types (Legend Soil Map of the World, 1974)**
G1	Agricultural soils	B, Bc, Bd, Be, Bf, Bh, Bk, Bv, C, Cg, Ch, Ck, Cl, De, H, Hc, Hh, Hl, K, Kh, Kk, Kl, L, La, Lc, Lf, Lk, Lo, Lp, Lv, Mo, Nd, Ne, Nh, T, Th, Tm, To, V, Vc, Vp
G2	Soils of wetlands, poorly drained areas and floodplains	Ag,Bg, Dg, G, Gc, Gd, Ge, Gh, Gm, Gp, Hg, J, Jc, Jd, Je, Jt, Lg, Mg, O, Od, Oe, Ox, Pg
G3	Sandy soils	Qa, Qc, Qf, Ql, Q
G4	Sodic and saline soils	S, Sg, Sm, So, Ws, Z, Zg, Zo, Zt, Zm
G5	Rock outcrops and shallow soils	E, I, RK, U
G6	Semi-desert soils	X, Xh, Xk, Xl, Xy
G7	Desert soils	Y, Yh, Yk, Yl, Yt, Yy
G8	Non-agricultural soils	Bx, Gx, R, Rc, Rd, Re, Rx, Tv,Wd, We, Wm
G9	Soils with high acidity and/or low nutrient status	Af, Ah, Ao, Ap, D, Dd, Fa, Fh, Fo, Fp, Fr, Fx, P, Ph, Pl, Po, Pp
G10	Glaciers	GL
G11	Mobile sands	DS
G12	Salt flats	ST
G13	Water bodies	WR

Using these new soil groupings the units of the Soil Map of the World were converted by reclassifying the 1047 FAO soil associations into 60 Soil Management Domains (SMD). The SMDs are thus regroupings of the FAO soil associations on the basis of the main management properties of the soils, through combinations of the main soil management groups. Section 3.3.4 contains the list of SMDs that occur in the breed distribution areas, as well as their short descriptions.

2.5. MAPPING ADAPTABILITY ZONES FOR THE BREEDS OF THE PILOT COUNTRIES

The key concept for assessing to which environments the breeds of the pilot countries could be adapted is *similarity in physical environments* with the breed distribution areas. Thus the breed distribution maps and their associated physical characteristics are the basis for identifying areas outside the current breed areas where the breeds in question are likely to be adapted. In this study we assessed similarity *at the global scale* at a spatial resolution of 30 arc-seconds (about 1 km in N-S direction).

The methodology for assessing similarity takes into consideration the more permanent characteristics of the biophysical environment: climate, topography and soils. It did not include land use/land cover as this is often a fairly dynamic attribute and, moreover, current global land use/land cover maps were not considered of adequate accuracy for this exercise to be meaningful.

In similarity analysis, the value of a parameter or index at one location (the 'match' location) is compared with other ('target') locations in order to quantify the degree of similarity. In this particular case the thematic pattern in each one of the breed distribution areas, as drawn by the national collaborators, has been used as representing the match location. The target area is the entire land area of the earth with the exception of Antarctica, Greenland, and other glaciated areas. Excluded from the similarity analysis were also the *hyper-arid areas*, or true deserts (i.e. with an annual aridity index below 0.03). These areas were simply excluded by masking them.

The similarity mapping was done in different stages: similarity in temperature, in precipitation, landforms and soils were mapped separately using individual similarity indices and the thematic similarity indices were then combined into an overall similarity index for the natural environment.
The methods for similarity mapping of temperature and precipitation are essentially the same as those used for a regional study of the Karkhe River Basin in Iran (De Pauw et al., 2008), with this difference that for the current study new software has been developed that makes global assessments feasible. The methods for assessing soil and landform similarity are new and have been applied for the first time in this study.

Several computer programs were developed to automate the process, which are included on the DVD. In the course of the study a 'striped map' software bug was discovered and corrected.

2.5.1. Data sources

The following spatial data sources were used as input to the similarity mapping at the global scale:

1) For temperature similarity:
Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. Int. J. Climatology 25: 1965-1978 (http://worldclim.org/current)

2) For precipitation similarity:
Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. Int. J. Climatology 25: 1965-1978 (http://worldclim.org/current)
De Pauw, E. 2008. Climatic and Soil Datasets for the ICARDA Wheat Genetic Resource Collections of the Eurasia Region. Explanatory Notes. ICARDA GIS Unit, Aleppo, Syria.68 pages. (http://geonet.icarda.cgiar.org/geonetwork/data/regional/GRU_NetBlotch/Doc/Report_NetBlotch.pdf).

3) For landform similarity:
SRTM30 Digital Elevation Model (http://topex.ucsd.edu/WWW_html/srtm30_plus.html)

4) For soil pattern similarity:
FAO-UNESCO.1995. The Digital Soil Map of the World and Derived Soil Properties. Land and Water Digital Media Series 1. FAO, Rome, CD-ROM.

5) For similarity in natural environment: all of above data sources

2.5.2. Mapping climatic similarity

The model used to assess climatic similarity is the combination of two distance functions, one for the temperature and another one for precipitation:

(Eq.1) $$S = Min(I_{1(\Delta_t)}, I_{2(\Delta_p)})$$

with Min: the lowest of the two values

The functions I_1 and I_2 are *similarity indices* for respectively air temperature and precipitation. These functions draw inspiration from the 'Match Index' concept developed in the CLIMEX software (Sutherst, 1999). They model the drop in similarity under increasing dissimilarity for air temperature Δ_t and precipitation Δ_p , respectively, as

(Eq.2) $$I_1 = e^{\left(-\frac{\Delta_t}{\sigma_t}\right)} \quad \text{and} \quad I_2 = e^{\left(-\frac{\Delta_p}{10\times\sigma_p}\right)}$$

with σ_t [$^{O}C^{-1}$]and σ_p [mm^{-1}]user-defined calibration constants (Fig. 2).

The assessment of similarity can be fine-tuned by user-defined calibration constants. Calibration constants determine the form of similarity decay functions (Fig.2), which model the drop in similarity under increasing difference in precipitation or temperature, and are user-selected. The role of the calibration constant is thus to adjust the sensitivity of the similarity index in terms of what the user expects as reasonable measures of quantified differences in the patterns of temperature or precipitation between the breed areas and the target locations. In this study the calibration factor for air temperature σ_t was empirically set to 7.0, which corresponds to a drop in similarity by 20% under Δ_t = 2^{O}C and of about 50% under Δ_t = 5^{O}C. The calibration factor for precipitation $\sigma_p$was set to 3.0, which corresponds to a drop in similarity of 50% under Δ_p = 20 mm and of about 80% under Δ_p = 50 mm.

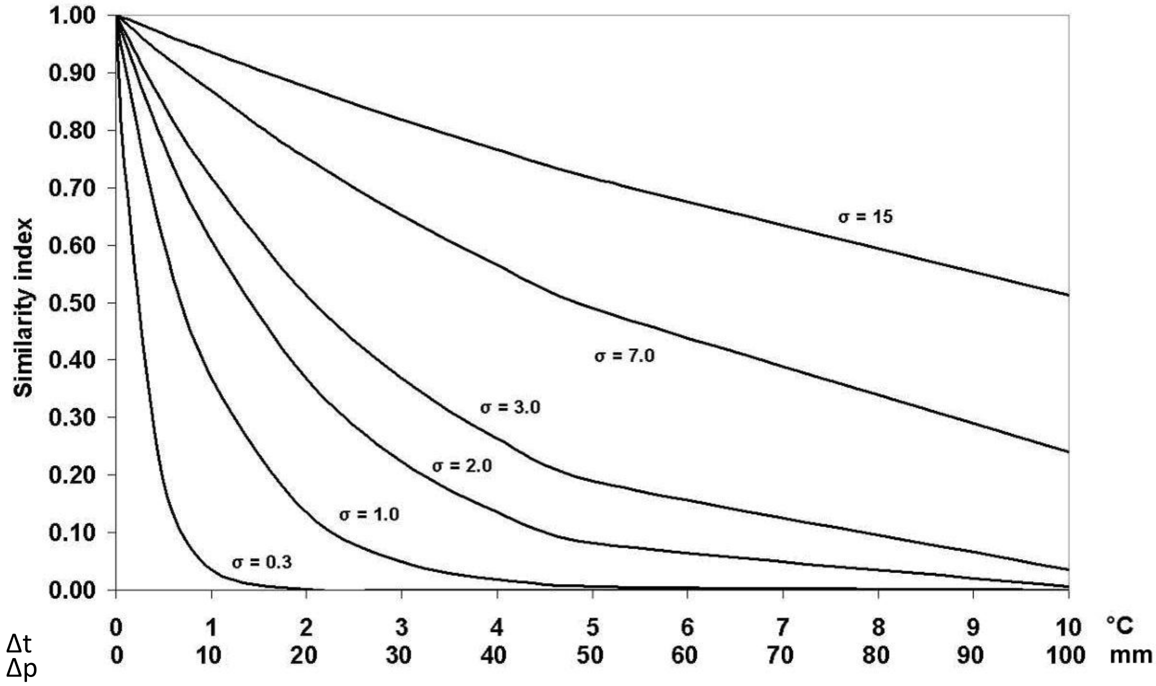

Figure 2. Use of calibration factors to adjust sensitivity to a climatic parameter

Climatic similarity is assessed on the full precipitation and temperature record. Twelve monthly values of average temperature and total precipitation are used. Similarity is quantified by the sum of squared distances between the parameter values of the match and each target location, using a scale of 0 (or 0%, totally dissimilar) to 1 (or 100%, totally similar).

In order to avoid artificial dissimilarity due to different timing of growing periods (e.g. when comparing climates in different hemispheres), the temperature curves of the match and target locations are aligned first in such a way that the timing of the minimum and maximum temperatures has a maximum overlap. Data input was in the form of climatic grids (12 mean monthly precipitation and average temperature surfaces). To assess similarity, grids were used with SRTM30-DEM resolution (30 arc-second; 1 km).

The dissimilarity in temperature Δ_t was computed as follows (De Pauw, 2002):

(Eq. 3) $$\Delta_t = \sqrt{\frac{\sum_{i=1}^{12} \left(t_{i+s} - T_i\right)^2}{12}},$$

wherei is month number, *t* is mean monthly air temperature in the target point, *T* is mean monthly air temperature in the matching point (^{O}C), *s* is a *phase shift* in month numbering.

The phase shift minimizes the deviation in temperature between match and target location that could result from differences in geographical location and latitude. It is particularly important at the global scale as it allows to compare locations in both the northern and southern hemisphere by synchronizing the seasonal temperature pattern.

The phase shift was obtained by shifting the temperature array until the covariance:

(Eq.4) $$Cov(\overline{Tm},\overline{T}) = \sum_{i=1}^{12}(Tm_i - \overline{Tm}) \cdot (T_i - \overline{T})$$

reaches a maximum. The highest possible phase is 11.

The co-variance is very sensitive to small differences in monthly temperature between different locations and its use could, under certain conditions, produce in some areas a phase that is different from the one in its immediate surroundings in what is otherwise a climatically homogeneous region, leading to noisy patterns. To avoid that a *generalization procedure* is undertaken in the GIS software on the phase shift layer, which in ArcGIS 10 software can be described under the following steps:

- the Shift FLT-file is converted to raster
- the continuous floating point raster is converted to integer raster
- the **FocalStats** procedure is run twice with the settings Rectangular neighborhood (**5x5**) and **Majority** statistic
- the **Boundary Clean** procedure is run with sorting technique **Descend**
- a global Land Mask is used to extract the final generalized Shift layer

Once the phase shift (s) is established, it was applied to calculate the dissimilarity in precipitation pattern (Δ_p):

(Eq. 5) $$\Delta_p = \sqrt{\frac{\sum_{i=1}^{12}\left(p_{i+s} - P_i\right)^2}{12}},$$

where *p* is monthly precipitation in each target point, *P* monthly precipitation in the match point.

The above formulas apply for a similarity assessment based on a point to point comparison. However, breed distribution areas, particularly large ones, may contain a range of precipitation and temperature conditions. To ensure that the internal climatic variations did not exaggerate the dissimilarity that may arise by taking only one point inside the breed area, the precipitation and temperature conditions in two points were considered, that represent a **minimum** and a **maximum value** (Fig.3).

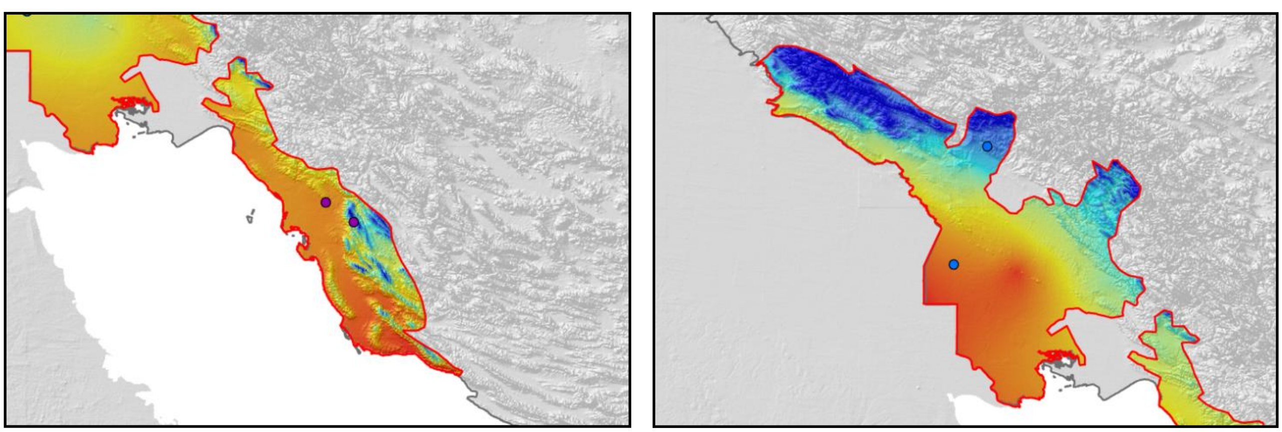

Figure 3. Assessing area similarity using two points along a gradient of precipitation (left) and temperature (right)

These values were obtained by sorting all values of mean annual precipitation and temperature in the specific breed area and retaining the 1st and 9th decile values.

A computer program *Extremes Excluder* was developed for filtering out extreme values and identifying the 1st and 9th decile values. These values were then used to identify two locations for the precipitation gradient and two locations for the temperature gradient representing about 80% of the climatic conditions inside the breed area.

If a monthly temperature value for the target location was between the monthly temperature values of the two match locations, the dissimilarity (Eq.3) for that month was set to zero. If higher than the highest of the two match location values, the dissimilarity was calculated between the target location and the highest of the two match location values. If lower than the lowest of the two match location values, the dissimilarity was calculated between the target location and the lowest of the two match location values. The same procedure was adopted for calculating the monthly dissimilarity for precipitation (Eq. 5).

As mentioned before, to ensure that the similarity index for production zones with low precipitation does not lead to a misleading impression of high similarity with deserts, *hyper-arid areas* in which no sheep or goats are sustainable except in oases, have been masked.

2.5.3. Mapping soil similarity

Soil similarity was assessed by comparing the composition of the soil association within the breed distribution areas with the soil composition of each land pixel. The soil composition of both the breed distribution areas and areas outside was obtained from the Digital Soil Map of the World (1995) using the soil classification established by FAO for this map (1974). As the legend for this map is a very complex one, containing more than 100 classes, the soils have been regrouped into broad soil management groups, which have similar properties in terms of soil management. These soil management groups, as well as the FAO soil classes they contain, are shown in Table 5. For more details on the symbols and definitions of the FAO soil types is referred to the Legend of the Soil Map of the World (FAO, 1974).

Soil similarity was evaluated by applying the **Sørensen similarity index** to the management groups (G1, G2 ... G13) in accordance with the following steps:

1. If G1 is not present in both the breed distribution area and in the target pixel, no similarity index is calculated.
2. If G1 is present in the breed distribution area but not in the target pixel, or vice versa, the similarity index is zero.
3. In all other cases the similarity index for soil management group G1 is calculated as:

$$Sim_{soil_{G1}} = \frac{Min(\%G1_d, \%G1_t) * 2}{\%G1_d + \%G1_t}$$

with Min: the lowest value of the two
$\%G1_d$: proportion (%) of SMG G1 in the soil composition of the breed distribution area
$\%G1_t$: proportion (%) of SMG G1 in the soil composition of the target pixel

4. Steps 1-3 are repeated for soil management groups G2, G3 ... G13.
5. The total soil similarity is calculated as a weighted average of the similarity indices for each soil management group as follows:

$$Sim_{soil_{all}} = \sum_{i=1}^{13} Sim_{soil_{Gi}} * \frac{\%G_{i,d}}{100}$$

with $\%G_{i,d}$: proportion (%) of SMG G_i in the soil composition of the breed distribution area

2.5.4. Mapping landform similarity

Landforms were grouped into three classes based on the concept of 'relief intensity'. 'Relief intensity' is obtained from the SRTM30 DEM dataset and is derived from the maximum elevation difference between two neighbouring pixels. The three relief intensity classes are:

- L1: Plains; relief intensity 0-50 m
- L2: Hills; relief intensity 50-300 m
- L3: Mountains; relief intensity >300 m

For each breed distribution area the landform composition was recorded in terms of percentage plains (%L1), hills (%L2) and mountains (%L3).
The procedure for assessing *landform similarity* is very similar to the one used to assess soil similarity: by comparing the landform composition within the breed distribution areas with the landform of each land pixel, with the only difference that in the latter the landform is homogeneous (100% L1 or 100% L2 or 100% L3). The rules are thus:

1. If L1 is not present in both the breed distribution area and in the target pixel, no similarity index is calculated.
2. If L1 is present in the breed distribution area but not in the target pixel, or vice versa, the similarity index is zero.
3. In all other cases the similarity index for landform L1 is calculated as:

$$Sim_{L1} = \frac{(\%L1_d) * 2}{\%L1_d + 100}$$

with $\%L1_d$: proportion (%) of landform L1 in the landform composition of the breed distribution area

4. Steps 1-3 are repeated for landforms L2 and L3.

E.g. the distribution area of Moroccan sheep breed Beni Ahsen consists of 90% plain, and 10% hills.
If the target pixel is a plain, the landform similarity index is 0.9; if the target pixel is a hill, the landform similarity index is 0.2, if a mountain the index is 0.

2.5.5. Mapping similarity in all evaluated factors

The total similarity was calculated as the lowest of all evaluated factors.

$$S_{total} = \text{Min}\ (S_{climate}\ ,\ S_{LF}\ ,\ S_{Soils})$$

with$S_{climate}$ the minimum of the $S_{precipitation}$ and $S_{temperature}$ similarity indices, S_{LF} the landform similarity index and S_{soils} the soil similarity index.

The principle of the 'most limiting factor' is thus applied for integrating the similarity scores for each evaluated factor. Automatically the lowest score sets the final score: this is a tough rule but it avoids subjective weight factors of which the individual effects are later difficult to evaluate.
Similarity in precipitation and temperature patterns were calculated using a Visual Basic program developed in ICARDA, the other similarity factors were calculated in ArcGIS software.

2.6. COMPARISON OF DAD-IS SPATIAL DATA WITH ICARDA DATA FOR BREED AREAS

In order to assess to what extent the characterization of the breed environments is actually influenced by the quality and detail of the spatial data used, a comparison was made between some of the layers that are candidate for inclusion in the DAD-IS system and some data layers generated by ICARDA.

The following thematic layers were compared:

- the mean annual precipitation
- the mean monthly maximum temperature of the warmest month
- the mean monthly minimum temperature of the coldest month
- the climates according to Köppen

The comparison took the form of maps for all 4 countries (Figures 16-21 in section 3.3.5) and summary *difference tables* for some countries (Tables 81 to 100 in Annex 3). In these tables the values of each thematic layer were regrouped into a number of classes, common to both the DAD-IS and ICARDA datasets. For each breed area the difference was calculated in the percentage occurrence of each thematic class as quantified by either the DAD-IS or ICARDA dataset.

The first three datasets were obtained from the 10 Minute Climatology dataset (http://www.cru.uea.ac.uk/cru/data/hrg/tmc/) developed by the Climate Research Unit (CRU) of the University of East Anglia, Norwich, United Kingdom.
These datasets, which have the format of an Excel-compatible table, were converted first into ESRI shapefiles and the latter into ESRI raster files. These rasters were clipped using the shapefile boundaries of Egypt, Iran, Morocco and Turkey, obtained from the Digital Chart of the World database
The resulting 10-minute country raster files were compared with the high-resolution (30 arc-second) rasters of the corresponding thematic layers available in the ICARDA spatial database and generated in accordance with the method outlined in section 2.4.2.

The Köppen climate classification system, devised by Waldimir Köppen, is based on the annual and monthly averages of precipitation and temperature. Initially published in 1918, the original Köppen classification system has been revised several times, especially by Geiger and Köppen himself (Köppen and Geiger, 1928). Despite its venerable age, the Köppen climate classification is still the most widely used to date.
An updated Köppen climate dataset of the world (Peel et al., 2007) at 0.1 degree spatial resolution was downloaded from http://www.hydrol-earth-syst-sci.net/11/1633/2007/hess-11-1633-2007.html. The raster was clipped using the shapefile boundary of Iran and compared with the high-resolution (30 arc-second) rasters of the corresponding thematic layers available in the ICARDA spatial database. In this case the two layers differ not only in spatial resolution but also *in the detail of the classification*: whereas the Köppen climate dataset of Peel et al. contains 30 climate classes, the ICARDA Köppen climate dataset contains 57 classes.

3. RESULTS

3.1. CHARACTERISTICS OF THE SELECTED BREEDS

The key characteristics of the selected breeds, based on the questionnaires obtained from the national collaborators are provided in Tables 6-9. More details and the link to the DAD-IS entry are provided in Annex 1.

Table 6.Key attributes of selected breeds from Egypt

	Sheep	Tail	Wool/hair	Size *	Main product	Production System
1	Aboudeleik**	fat-tail, long	coarse wool or hair	5	meat	transhumance following rain; mixed herds
2	Kanzi**	fat-tail, long	coarse wool or hair	6	meat	transhumance following rain; mixed herds
3	Maenit**	fat-tail	coarse wool or hair	7	meat	transhumance following rain; mixed herds
4	Barki	fat-tail	open fleece less coarse than Rahmain and Ossimi; 69% fine 26.2% coarse	3	meat, wool	extensive transhumant grazing***
5	Fallahi	fat-tail	open coarse medium length luster	5	meat, wool	mixed cropping
6	Farafra	fat-tail	no info	7	meat, wool	Oasis
7	Ossimi	fat-tail	open coarse often glossy	2	meat, wool	mixed cropping
8	Rahmani	fat-tail	long, straight wool	1	meat, wool	mixed cropping
9	Saidi/Sanabawi	fat-tail, long	open, long, coarse, wool on belly, legs, forehead	4	meat	mixed cropping
10	Sohagi	fat-tail	coarse wool	3	meat	mixed cropping
	Goats					
1	AHS***		long hair, black	3	meat	pastoral
2	Barki		long hair, black	2	meat	extensive transhumant grazing*
3	Black Sinai		no info	3	meat	extensive grazing
4	Egyptian Baladi		long straight hair	1	meat	mixed cropping
5	Saeidi				meat	mixed cropping
6	Wahati		long glossy hair	2	meat	Oasis
7	Zaraibi		short hair	1	meat and milk	mixed cropping

*1=largest, 7=smallest;
**Aboudeleik, Kanzi and Maenit were later treated as subtypes of one breed because they are very similar in appearance and are kept in same area under similar systems;
***AHS goats are named after the Triangle Abouramad- Halaieb-Shalateen region in which they are found.

Table 7. Key attributes of selected breeds from Iran

	Sheep breed	% in population*	Tail in sheep	Wool/hair	Size**	Main product	Production System/Ecosystem
1	Afshari	2.8	fat tail		8	meat	semi-nomadic, mixed crop-livestock and village rearing
2	Arabi	2.8	small fat tail			meat- milk type, wool	nomadic, semi-nomadic, and village rearing
3	Bahmei	0.4	fat tail			meat	nomadic and semi-nomadic
4	Baluchi	12	round fat tail		3	meat, wool	nomadic and semi-nomadic
5	Shal (Chal)	0.9	fat tail	coarse	7	meat	mixed crop-livestock and village rering
6	Dalagh	0.2	semi-fat tail	coarse carpet	3	meat	semi-nomadic, mixed crop-livestock and village rearing
7	Ghezel (Kizil)	4.6	fat tail	coarse carpet wool	5	meat, milk, carpet wool	semi-nomadic, mixed crop-livestock and village rearing
8	Gray Shiraz	0.9	small fat tail	coarse	5	meat, pelt, milk	nomadic, semi-nomadic, and village rearing
9	Karakul (black)	0.6	long fat tail	coarse	5	meat, pelt, milk	semi-nomadic, mixed crop-livestock and village rearing
10	KurdiKurdestan	2	medium fat tail	coarse for quality carpets	6	meat, wool	semi-nomadic, mixed crop-livestock and village rearing
11	Lori (Lory)	8.3	large fat tail	coarse	6	meat	nomadic, semi-nomadic, and village rearing
12	Lori-Bakhtiyari		large fat tail	coarse	6	meat	nomadic, semi-nomadic, and village rearing
13	Makui	2.3	short fat tail	coarse carpet	4	meat (wool)	nomadic, semi-nomadic, and village rearing
14	Mehrabani	1.9	medium fat tail	coarse	2	meat	semi-nomadic, mixed crop-livestock and village rearing
15	Moghani	6.5	fat tail	coarse	4	meat-type (milk)	nomadic, semi-nomadic, and village rearing
16	Sangsari	0.2	medium fat tail	coarse	3	meat (milk)	nomadic, semi-nomadic, and village rearing
17	Sanjabi	1.9			5	meat, milk	semi-nomadic, mixed crop-livestock and village rearing
18	Taleshi	0.7	semi-fat tail	coarse	1	meat-type	semi-nomadic, mixed crop-livestock and village rearing
19	(Turki) Ghashghaei	2.8	small fat tail	coarse	3	meat-type (milk)	nomadic and semi-nomadic
20	Zandi	0.9	semi fat tail	coarse	3	meat, pelt, milk	semi-nomadic, mixed crop-livestock and village rearing
21	Zel	3.7	thin tail	coarse, low quality	1	meat-type	semi-nomadic, mixed crop-livestock and village rearing
22	Farahani	n.a.	fat tail	coarse carpet quality	n.a.	meat, milk	semi-nomadic, mixed crop-livestock and village rearing
23	Naeini	n.a.	fat tail	coarse carpet quality	n.a.	meat, milk	semi-nomadic, mixed crop-livestock and village rearing

	Sheep breed	% in population*	Tail in sheep	Wool/hair	Size**	Main product	Production System/Ecosystem
24	KordiKhorasani		medium fat tail	coarse	4	meat type, milk	
25	Fashandi	6.3					
26	Kermani						
27	Kalkohi		medium fat tail	high quality wool	5	meat type,	
	Goat breeds						
1	Tali	0.5		hair	med	milk, meat	mixed crop-livestock and village rearing in small family flocks
2	Adani						
3	Marghoz	0.1		Mohair	med	meat, Mohair	village rearing
4	Najdi	0.2		hair	med	milk, meat	semi-nomadic, mixed crop-livestock and village rearing
5	Raeini	7.4		Cashmere, hair	med	Cashmere, meat	nomadic and semi-nomadic
6	Balouchi (Birjandi)						
7	Nadoshan (Yazdi)			Cashmere, hair		Cashmere, meat	

*For population figures in 2000;
**from 1 (>30-35 kg) to 8 (>70 kg) in 5 kg intervals; med =medium

Table 8. Key attributes of selected breeds from Morocco

	Sheep	Tail in sheep	Wool/ hair	Fleece quality *	Size**	Main product	Production System
1	Timahdite	thin	coarse	3	2	meat, wool	pastoral
2	Sardi	thin		2	1	excellent meat	pastoral, agropastoral
3	BeniGuil	thin & short	medium fine	3	3	meat, wool	pastoral
4	D'man	thin &long	light, coarse	5	4	meat, manure, high fertility	Oasis
5	Boujaâd	thin	medium fine	2	2	meat, wool	Agropastoral
6	BeniAhsen	thin	finest wool, heavy fleece	1	1	meat, wool	Agropastoral
	Goats						
1	Atlas Mountain (Noire de l'Atlas)		hair			meat, milk	pastoral
2	Barcha		hair			meat, milk	pastoral
3	Draa		hair			meat, milk	Oasis
4	Argane Goat		hair			meat, milk	silvopastoral, Argane forest

*from best (1) to worst (5) fleece quality;
**from heaviest (1) to lightest (5)

Table 9. Key attributes of selected breeds from Turkey

	Breeds	% in population	Tail (in sheep)	Wool/ hair	Size	Main product	Production System/ Ecosystem
	Sheep						
1	Akkaraman (White Karman)* a) subtype Common	48.5	fat tail (5-6 kg)	best carpet quality	small	meat, milk	sedentary mixed systems
2	b) subtype Kangal		fat tail	coarse	largest	meat, milk	sedentary mixed systems
3	c) subtype Karakaş		fat tail	coarse	medium	meat, milk	transhumant
4	d) subtype Norduz		fat tail	coarse	medium	meat, milk	transhumant
5	Morkaraman (Red Karaman)	19	fat tail (5-6 kg)	coarse	medium	meat, milk	mixed system
6	Dağliç	7	fat-tail with thin end	known for carpet wool	smallest	meat	WesternMountain Area
7	Kivircik	5	thin tail	coarse	medium	milk, delicious meat	sedentary, hilly areas, good rainfall
8	Awassi	6-7	fat tail (3kg)	coarse	medium	milk, meat	mixed systems
9	Karayaka (black)	3	long thin tail	long wool, no crimp	medium to small	delicious meat, no milk, wool for matraz	Black Sea coast, high rainfall
10	Karacabey Merino (Crossbred with Akkaraman)	1-2	thin tail	dense, uniform wool	medium	meat, (milk)	mixed systems
11	Anatolian (Konya) Merino – (Crossbred with Morkaraman)	1.2	thin tail	dense, uniform wool	medium	meat, (milk)	transhumant
12	Sakiz (Chios)	< 1	semi fat tail	coarse	tall	milk, very fertile	coastal areas,
13	Gökçeada (Imroz)	< 1	thin-tail	long fleece (23 cm)	medium	meat, milk	mixed systems
14	GüneyKaraman (Black Karaman)	< 1	fat rump/tail	coarse	small	meat	cold mountain
15	Herik (Sirrt)	< 1	long fat tail	coarse (Carpet)	small	milk, meat	mixed systems
16	Tuj (Tujin)	< 1	fat tail	coarse, low quality	small	meat, milk	transhumant

	Breeds	% in popula -tion	Tail (in sheep)	Wool/ hair	Size	Main product	Production System/ Ecosystem
17	Hemşin (Morkaraman x Karayaka)	< 1	thick thin tail	coarse	small		Black Sea mountains, high rainfall in 10-15% of Karayaka area
18	Herik (Sirrt in Iraq)	< 1	long fat tail	mixed coarse	medium	meat, milk	Mixed systems, South East Turkey
19	Tahirova (crossbred with Kivircik)	< 1	thin tail			milk, meat	Sedentary
20	Ödemiş**	Extinct (begin 80ties)	fat tail (18 kg)	coarse, short	medium	meat, milk	
	Goats						
1	Kil (Hair)	> 90		rough hair	medium	cheese	Mountain agriculture, transhumance
2	Kilis (Damascus (20-85%) x Kil cross)	6-7		hair	medium	milk, meat	base areas, foothills
3	Angora	1-2		Mohair	small	mohair	base areas, foothills
4	Maltese (Maltiz	< 1		hair		milk, meat	Coastal, higher rainfall, orchards, &vegetables
5	Norduz	< 1		hair	medium	milk, meat	higher rainfall
6	Gürçü (from Georgian immigrants)	< 1		hair	no info	milk, meat	Transhumant, higher rainfall

*The four Akkaraman subtypes were counted as full breeds because of their distinct distributions
**No questionnaires is available for the Ödemiş.

The 84 breeds[5] described in the questionnaires were still present in the countries, and with the exception of seven breeds (two in Morocco, one in Egypt and four in Turkey) no starting year was given for any of the other breeds indicating that these breeds have been present in the countries for a long time.

3.1.1. Production systems and management

While in three countries a high proportion of sheep and goat breeds (Morocco 70%, Turkey 60%, and Egypt 67%) were reported to be kept in sedentary crop-livestock systems, in Iran 91% of sheep and goat breeds are kept in transhumant systems (nomadic/semi-nomadic combined with mixed systems). The majority (73 out of 84) of sheep and goat breeds was reported as free-ranging with confinement at

[5] The information on special breed characteristics is not available for the extinct sheep breed in Turkey.

night; ten (7 breeds in Egypt, 1 in Iran and 2 in Turkey) were reported as being confined on a seasonal basis and only the two oasis breeds in Morocco are continuously confined.[6]

In the vegetation period the majority of small ruminant breeds in Turkey and Iran mainly depends on rangelands: for 76% and 100% of the small ruminant breeds, respectively in these countries equal or more than 80% of the feed stems from natural rangelands; outside the vegetation period there is still a contribution from rangelands but mostly below 50% and in most cases crop residues present the highest proportion of feed. The situation in Egypt and Morocco[7] differs as 67 and 50% of the breeds, respectively, get equal or less than 50 % of their dry matter from rangelands; instead their main feed base is forages or crop residues in combination with varying proportion of concentrates. Overall the information of feeding differed between the main systems and very little between the breeds.

3.1.2. Environmental challenge and specific adaptations

For 46 out of 50 breeds in Turkey, Egypt and Morocco it was reported that that feeding was frequently or throughout the year restricted; exceptions were Chios sheep in Turkey and the sheep and goat breed typical for the oasis system in Morocco. For all sheep and goat breeds in Iran it was reported that feeding was not restricted; however, this does not look plausible given that most breeds are kept in transhumant systems depending on rangelands. Corresponding with the high dependence on rangelands and/or frequent feed restrictions the majority of sheep breeds in Turkey (71%), Egypt (100%) and Iran (96%) are fat- or semi fat-tailed; exceptions are the sheep breeds in Morocco that are all thin-tailed. Related to these characteristics 73 out of 84 breeds were reported to be adapted to long walking distances except the oasis sheep and goat breed in Morocco, two goat and three sheep breeds in Turkey as well as one goat and one sheep breed each in the other two countries[8].

Adaptation to long intervals between feeding were reported for 74 % of all breeds and the same breeds (with 7 exceptions) are also assumed to be adapted to long intervals between watering. The latter trait was reported for a total of 79% of the breeds; non adapted breeds were 4 sheep and 4 goat breeds in Egypt, 2 sheep and 1 goat breed in Morocco and 4 sheep and 2 goat breeds in Turkey and 1 goat breed in Iran. However, restriction in access to water as an environmental challenge was only reported for 16 breeds.

Overall, only fifteen per cent of the breeds are adapted to cold humid climates, mostly sheep breeds in Turkey and in Iran (Table 2). Adaptation to heavy snowfall was also reported quite rarely (22 out of 84); and with three exceptions the same breeds are assumed to be adapted to snowy/iced substrates.

In contrast, the proportion of breeds that was stated as adapted to solar radiation is with 46% quite high About half of the goat and sheep breeds were reported to be adapted to steep terrains but much fewer are assumed to be adapted to high elevations (only 17 out of 84 breeds), mainly sheep breeds in Turkey and goat breeds in Morocco. Even fewer breeds (13%) are adapted to stony ground (1 Moroccan goat and 2 sheep breeds, 3 Turkish and 1 Iranian sheep breed). One Moroccan sheep breed, four Egyptian goat and four sheep breeds as well as one Turkish goat and two sheep breeds were reported to be adapted to extremely sandy substrates.

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[6] The responses to the question about climate modifier are not reported here, because often they do not seem plausible compared with the other information given for a specific breed; furthermore the responses differed very little between the breeds; the question needs a better explanation.

[7] In Morocco no distinction was made between in and outside the vegetation period.

[8] In the Annex tables 15-18 we indicated the breeds that were not reported to be adapted to walking long distances as they were the "exceptions to the rule".

Adaptation to saline water was reported for only three oasis breeds (in Morocco and Egypt) and two other Moroccan sheep breeds; and among those only the Moroccan Draa goat was reported as adapted to drinking water with low pH.

The breeds with rare adaptive traits or those with interesting combinations of adaptive traits should be further evaluated (they are shaded grey in the Annex tables 16-19).

Table 10. Number of sheep and goat breeds with special adaptive traits by country (in total 84 breeds)

Country	Egypt		Morocco		Iran		Turkey		Total
Species	G*	S**	G	S	G	S	G	S	
Adapted to									
Cold/high humidity				1	1	3	2	6	**13**
Steep terrain			1	1	5	26	3	5	**41**
High elevation	1	1	3	1	1		2	8	**17**
High solar radiation	5	4	3	3		6	4	14	**39**
Extremely stony/rocky substrates			1	2		1	2	5	**11**
Heavy snowfall				1	1	5	3	12	**22**
Snowy/iced substrates				1	1	4	3	10	**19**
Extremely sandy substrates	4	4		1			1	2	**12**
Drinking water with low pH			1						**1**
Saline water	1		1	3					**5**

* G=goats; **S=sheep

Some interesting characteristics of products were reported for Turkish, Egyptian and Moroccan breeds, while for Iran the product information given was the same for all goat breeds and all sheep breeds.

3.1.3. Socioeconomic characteristics

As expected, the question on market orientation was answered with subsistence and market oriented in 95% of the cases. For the products of all breeds in Iran local, national and regional markets are targeted; in the other countries regional markets are only targeted for six sheep and two goat breeds in Turkey, while products from all other sheep and goat breeds target mainly local or national markets. Niche markets were reported mainly for dairy products (for 5 sheep breeds in Turkey, for 3 goat breeds in Egypt and 1 goat breed in Morocco[9]) and for mohair from Angora goats in Turkey.

As expected, decision making in the countries was dominated by men, with no exception in Turkey, a few exceptions in Morocco and some in Egypt. For example, in the oasis and agroforestry system of Morocco women were involved in decisions on the scale of operation, intensity of production and sales; in Egypt there seems to be some involvement of women in decisions on sales and the markets targeted. In Iran for all breeds the community is involved in decisions on breeding objectives. The information on work sharing was not differentiated by breed but rather by system. As expected feeding, watering, cleaning, and product harvesting was reported to be done by women and children; in some cases

[9] For Morocco selling kids and lambs for Aid Al Adha was reported for all sheep and goat breeds as niche market, however in our view this is one of the main uses of sheep and goat meat in Muslim communities and should be better reported as local/regional marketing.

involvement of men in feeding and product harvesting was indicated. Herding was stated to be the responsibility of men and/or children and sometime the community. Marketing was denoted most often as the domain of men, with involvement of women for 15 breeds, mainly in Egypt and Morocco. Health and reproductive management were stated as the responsibility of men and the community in Iran, and of men in Turkey; in Egypt and in Morocco there was more involvement of women in either health or reproductive management or both.

3.2. BREED DISTRIBUTION AREAS

The distribution areas of the selected breeds in the four countries vary in size by a factor 100, from the smallest (Boujaad O in Morocco, 602 km^2) to the largest (Hair Goat in Turkey, with 688,297 km^2 covering nearly the entire country (Table 11). The locations of the breeds are shown in the maps in Figures 4-13. Given the large number of sheep breeds in Iran and Turkey, they are shown on two maps for each country in order to avoid excessive overlap and confusing boundaries.

The distribution areas of breeds that are resistant to high humidity are shown on the maps with a red outline, of breeds tolerant to cold or heavy snowfall with blue outline, and in other colors for the remaining breeds.

Table 11. Areas (km^2) of the selected breeds

Country	Sheep breed	Area	Goat breed	Area
Egypt	Abudeleik / Kanzi /Maenit	22,213	Aburamad, Halaieb, Shalatin	22,095
Egypt	Barki	12,633	Barki	12,939
Egypt	Farafra	4,653	Black Sinai	59,377
Egypt	Indigenous (Baladi)	157,015	Indigenous (Baladi)	109,743
Egypt	Ossimi	12,452	Saidi	78,592
Egypt	Rahmani	11,422	Wahati	4,642
Egypt	Saidi / Shanabawi	79,152	Zaraibi	20,920
Egypt	Sohagi	34,725		
Iran	Afshari	37,364	Adani	24,901
Iran	Arabi	80,704	Birjandi (Balouchi)	249,110
Iran	Bahmei	11,915	Marghoz	17,997
Iran	Baluchi	424,973	Nadoshan	43,722
Iran	Dalagh	8,887	Najdi	33,639
Iran	Farahani	13,872	Raeini	177,637
Iran	Fashandi	7,292	Tali	119,396
Iran	Ghashghaye	57,986		
Iran	Ghezel	55,318		
Iran	Gray shiraz	65,040		
Iran	Kalkouhi	29,236		
Iran	Karakul (Black)	5,514		
Iran	Kermani	185,367		
Iran	Kord Khorasani	24,809		
Iran	Kurdi Kurdestan	43,204		
Iran	Lory	39,327		
Iran	Lory Bakhtiyari	85,169		
Iran	Makui	23,633		
Iran	Mehrabani	47,211		
Iran	Moghani	46,834		
Iran	Naeini	101,314		
Iran	Sangsari	103,885		
Iran	Sanjabi	29,461		
Iran	Shal	26,667		
Iran	Taleshi	19,334		
Iran	Zandi	46,115		
Iran	Zel	30,514		

Table 11. Areas (km2) of the selected breeds (continued)

Country	Sheep breed	Area	Goat breed	Area
Morocco	BeniAhsen G	5,794	Argane G	35,175
Morocco	BeniAhsen O	9,662	Atlas and Barcha G	64,821
Morocco	BeniGuil G	58,863	Draa G	18,117
Morocco	BeniGuil O	27,198		
Morocco	Boujaad G	2,669		
Morocco	Boujaad O	607		
Morocco	D'man G	28,434		
Morocco	Sardi G	38,422		
Morocco	Sardi O	9,410		
Morocco	Timahdite G	31,813		
Morocco	Timahdite O	6,884		
Turkey	Akkaraman (common)	382,541	Angora (eastern)	15,694
Turkey	Akkaraman (Kangal)	20,713	Angora (western)	205,028
Turkey	Akkaraman (Karakas)	12,417	Gurcu	19,893
Turkey	Akkaraman (Norduz)	3,206	Hair (Kil) Goat	688,297
Turkey	AmasyaHerik	4,114	Kilis	31,170
Turkey	Anatolian Merino	45,264	Maltese	17,745
Turkey	Awassi	72,853	Norduz	4,585
Turkey	Dagliç	71,878		
Turkey	Gökçeada	5,562		
Turkey	GuneyKaraman	15,823		
Turkey	Hemsin	8,738		
Turkey	Herik	8,537		
Turkey	Karacabey Merino	24,212		
Turkey	Karayaka	44,198		
Turkey	Kivircik	95,115		
Turkey	Morkaraman	160,167		
Turkey	Odemis	2,198		
Turkey	Sakiz	33,141		
Turkey	Tahirova	21,865		
Turkey	Tuj	9,860		

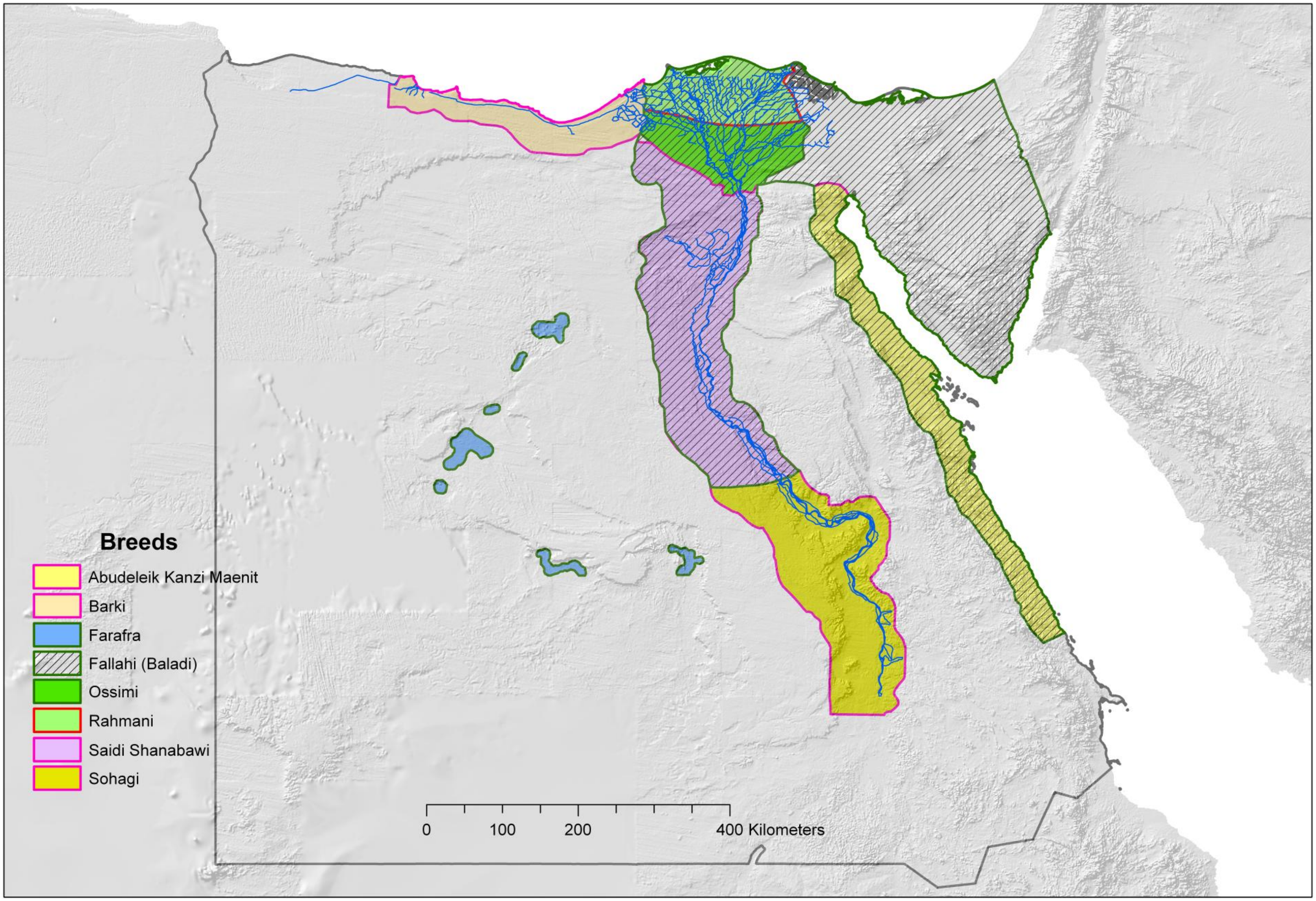


Figure 4. Distribution of selected sheep breeds in Egypt

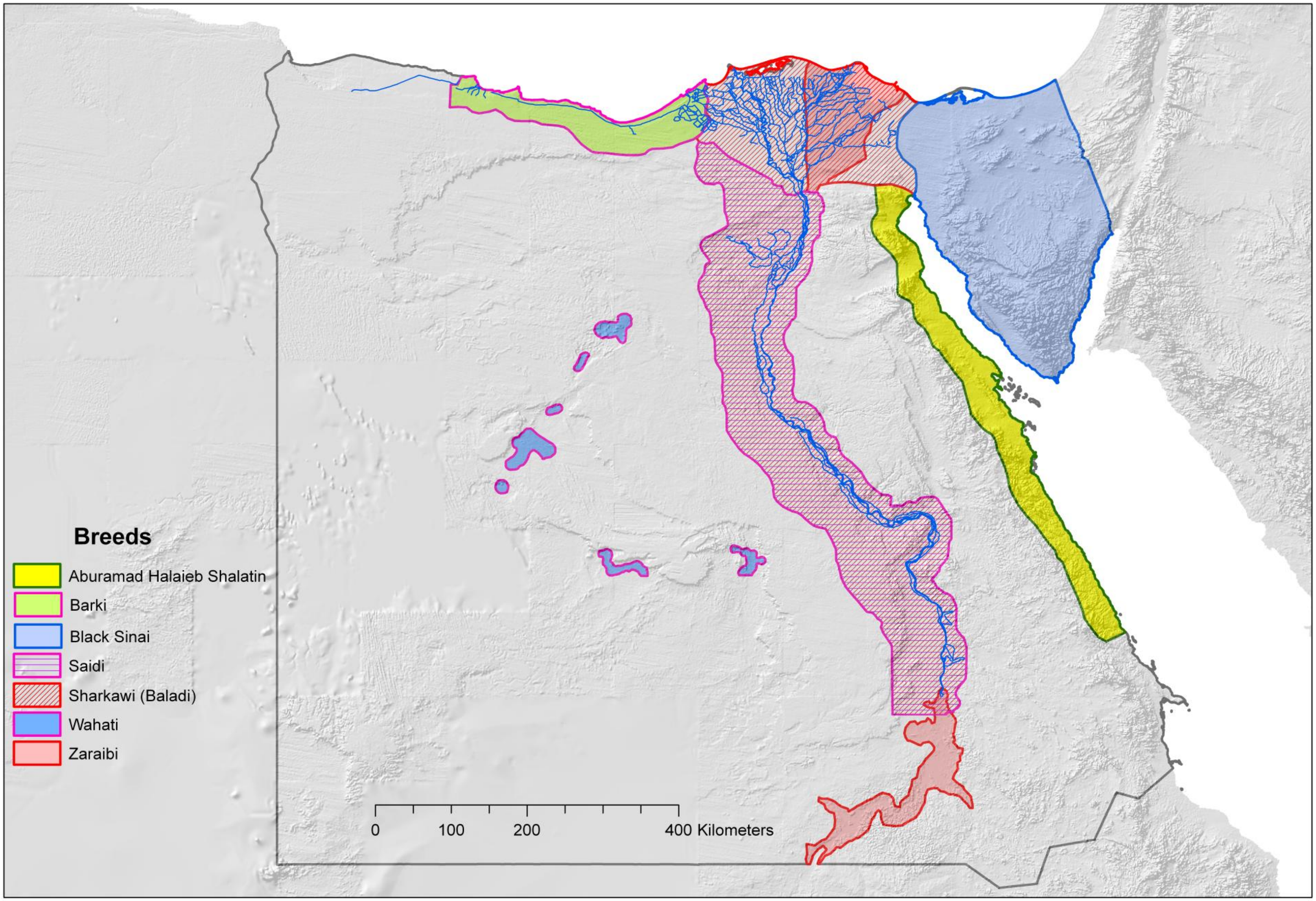


Figure 5. Distribution of selected goat breeds in Egypt

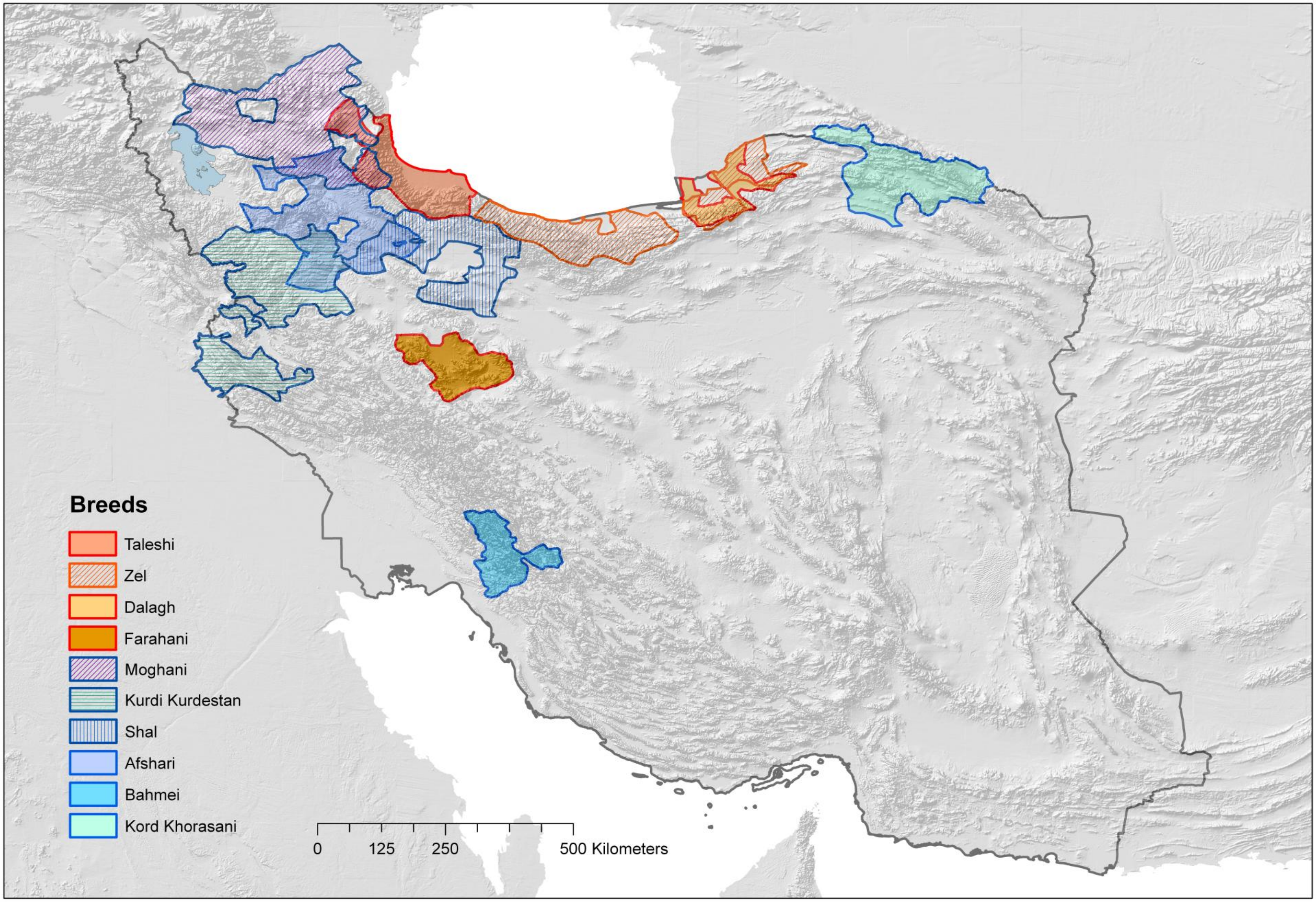


Figure 6. Distribution of selected sheep breeds in Iran (1)

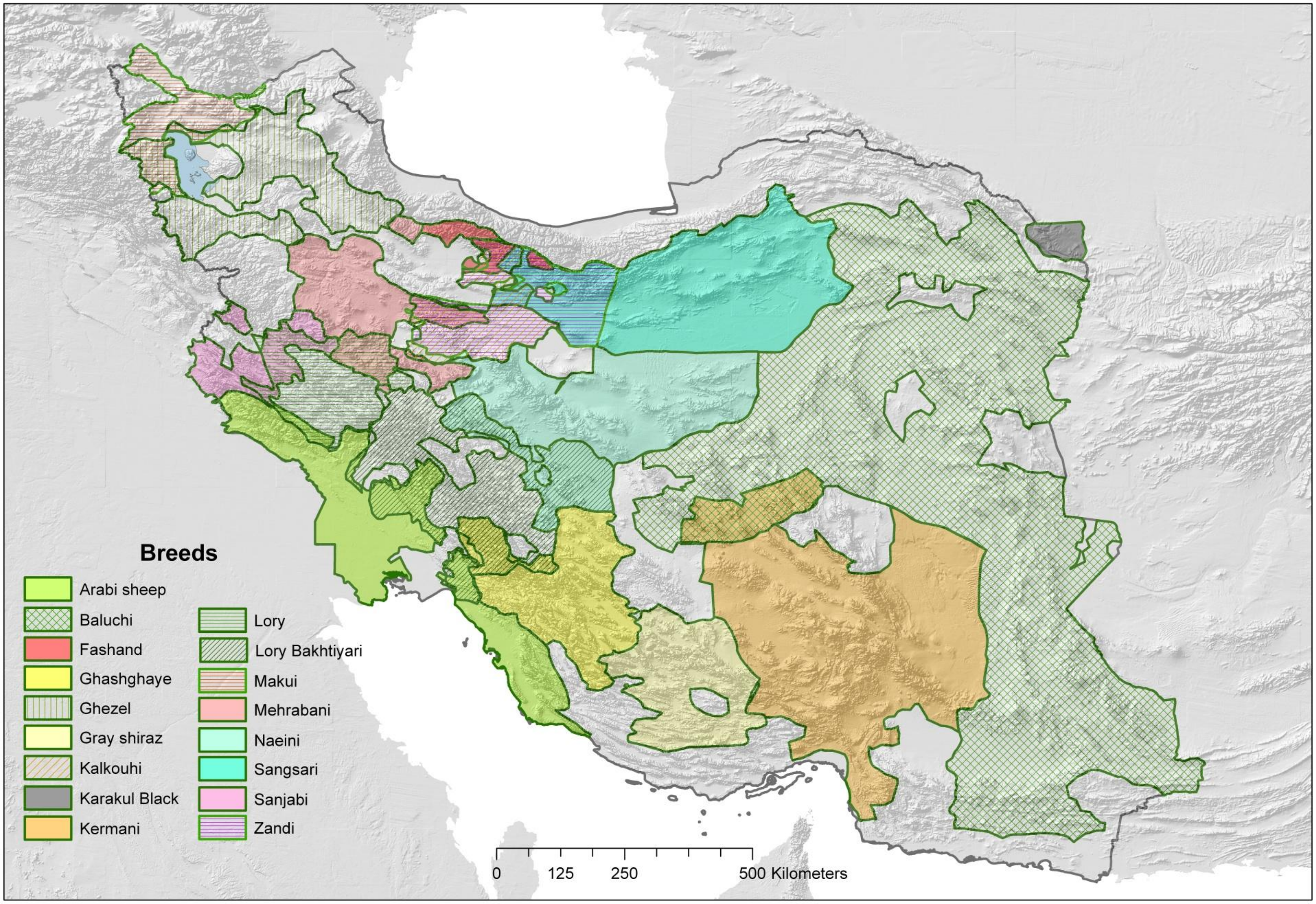


Figure 7. Distribution of selected sheep breeds in Iran (2)

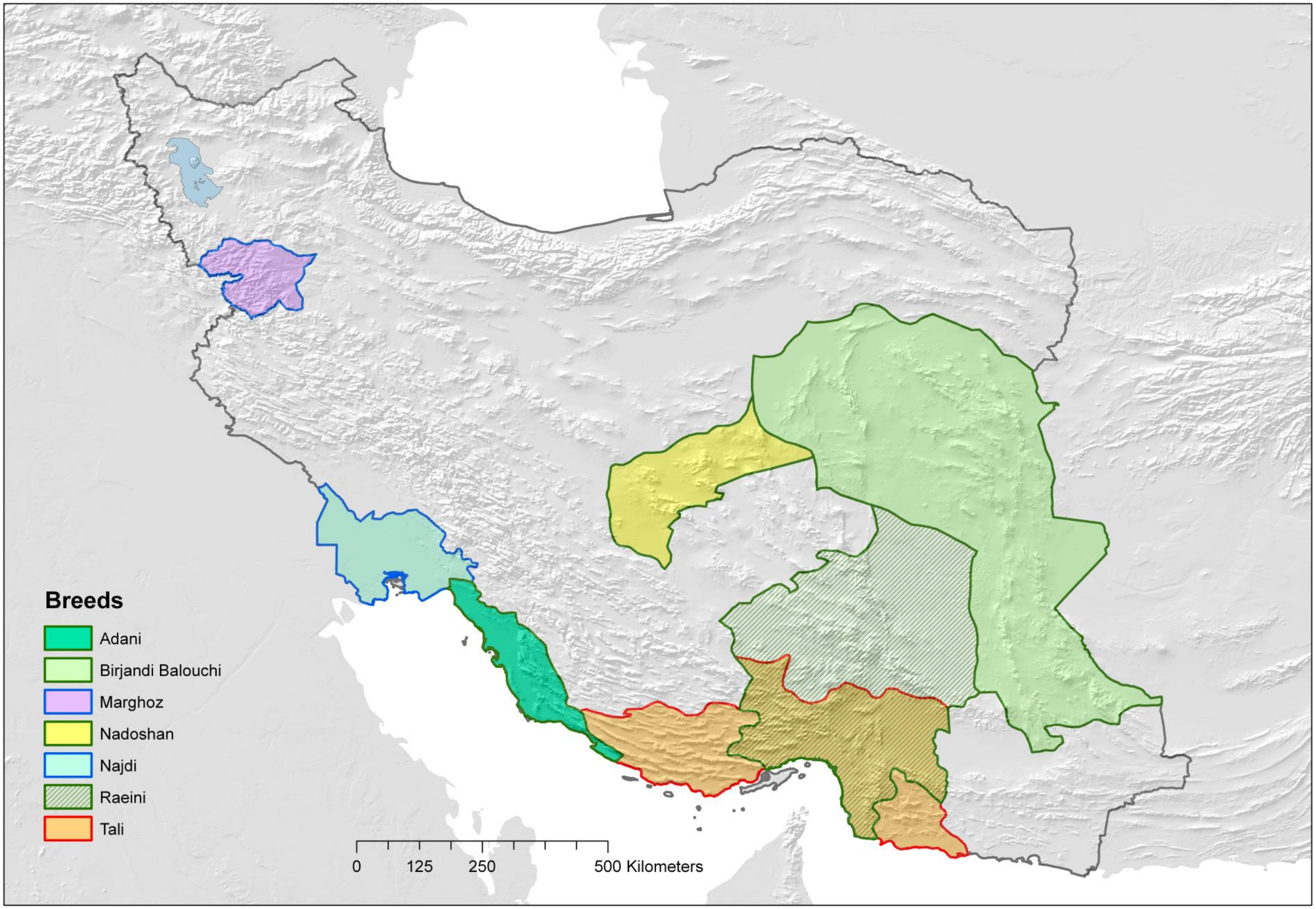


Figure 8. Distribution of selected goat breeds in Iran

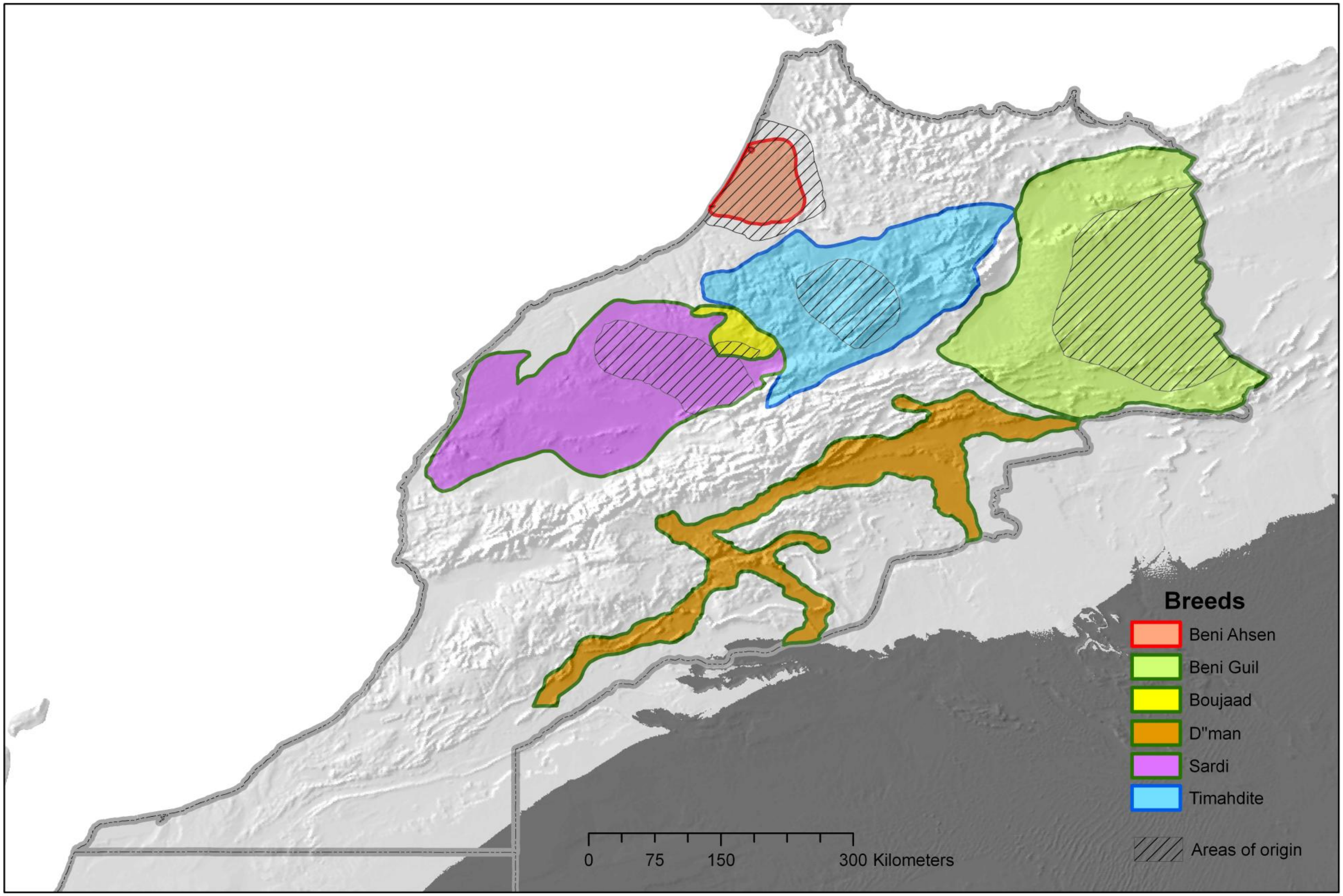


Figure 9. Distribution of selected sheep breeds in Morocco

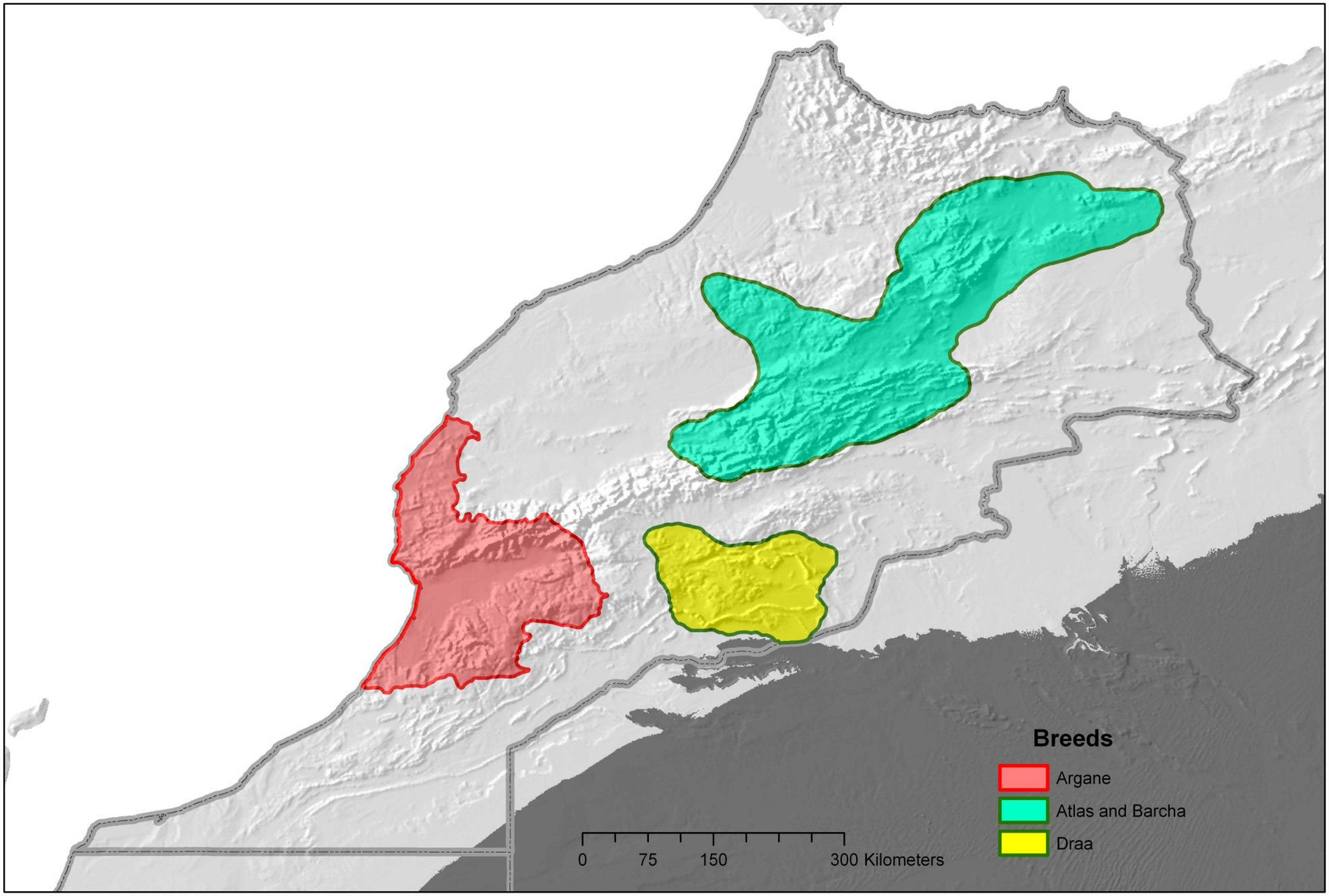


Figure 10. Distribution of selected goat breeds in Morocco

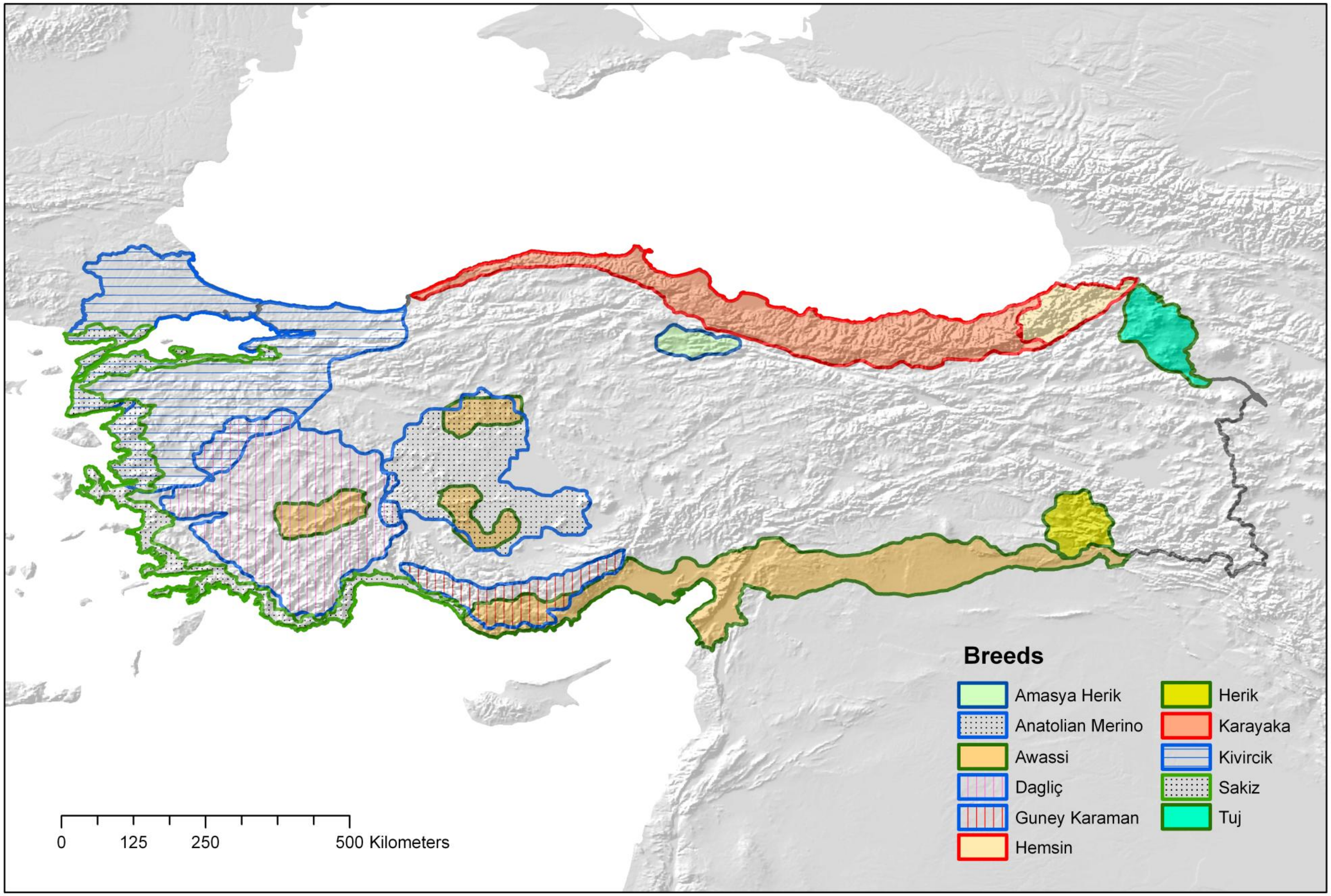


Figure 11. Distribution of selected sheep breeds in Turkey (1)

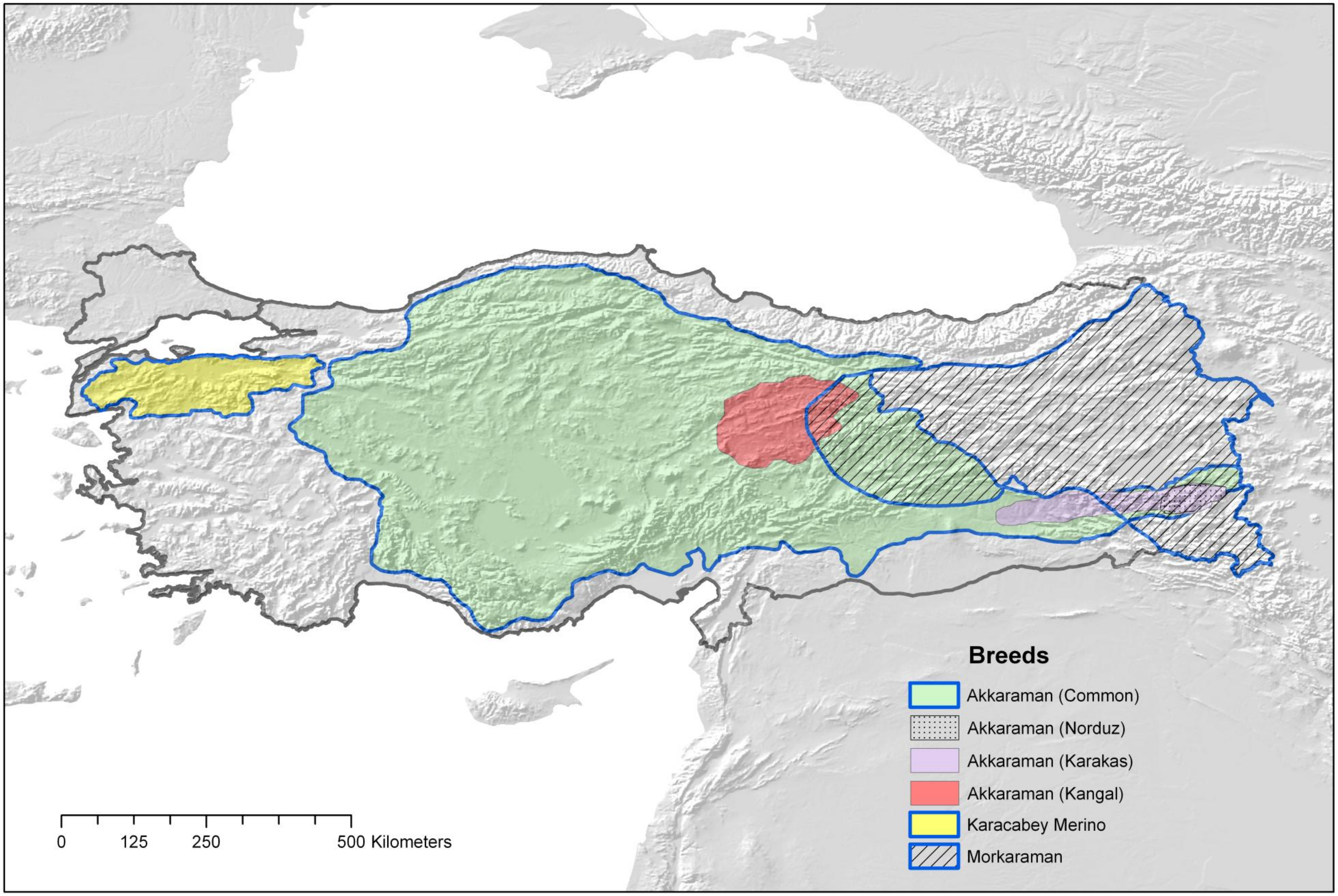


Figure 12. Distribution of selected sheep breeds in Turkey (2)

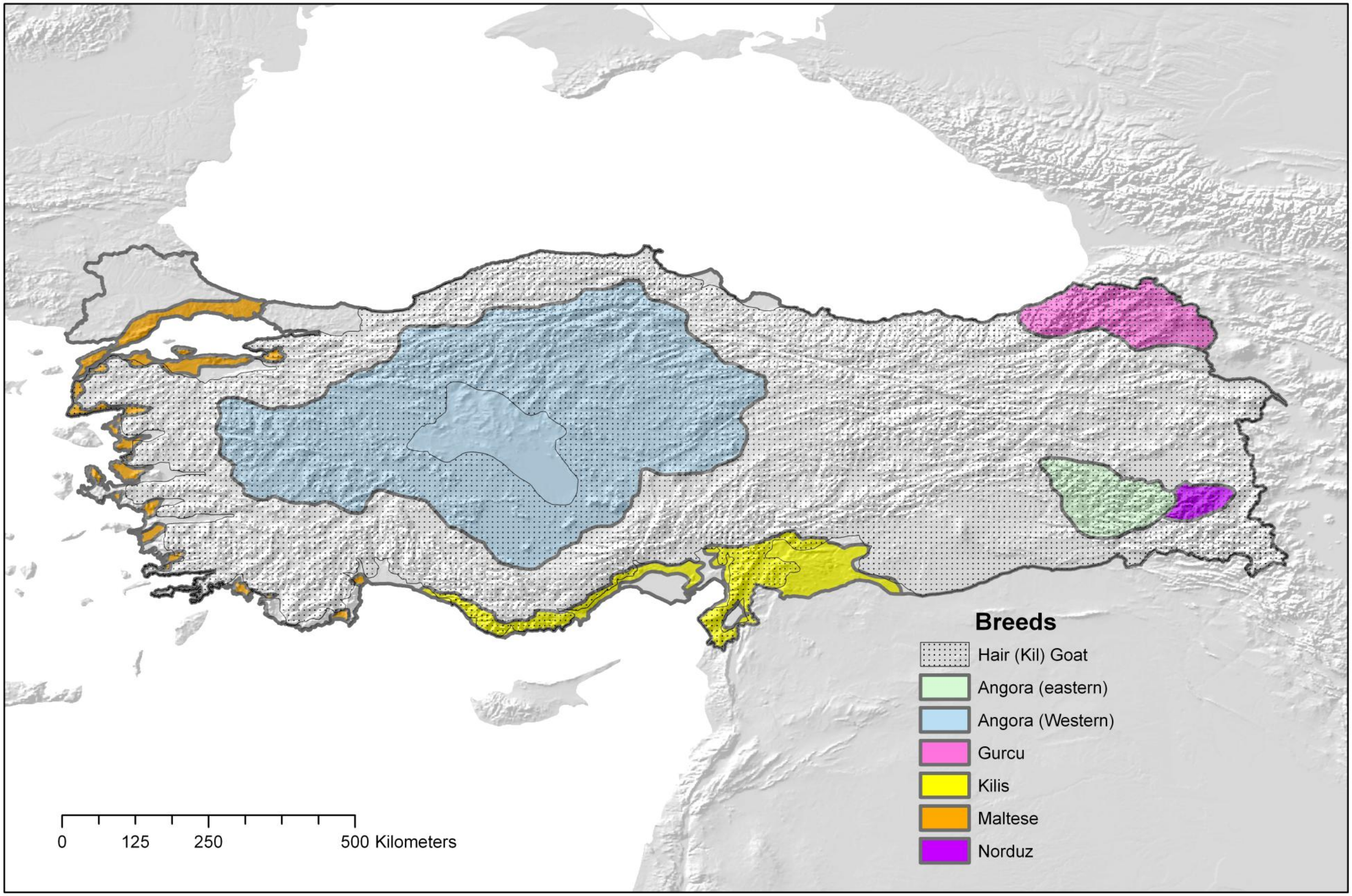


Figure 13. Distribution of selected goat breeds in Turkey

3.3. ENVIRONMENTAL CHARACTERISTICS OF THE SELECTED BREED DISTRIBUTION AREAS

3.3.1. General

The 85 sheep and goat breeds cover a very wide range of environmental conditions, as expressed by major differences in temperature, precipitation, land use/land cover, elevation and soils, and thus in the more integrated characteristics used in this study, such as agro-climatic zones, soil management domains and agro-ecological zones.

The range in precipitation is from less than 100 mm (in Egypt and Iran) to more than 2000 mm (in Turkey). The total area covers 36 agro-climatic zones (Table 12), with moisture regimes ranging from hyper-arid to per-humid, winter temperature regimes from cold to mild, and summer temperature classes from cool to very warm. All major landforms occur, plains, hills and mountains as well as all major land use/land cover types, including irrigated and rainfed crops. There are 36 soil management domains, which themselves are already integrated combinations of different soil types, regrouped according to key soil management properties. Putting all key variables together, excluding the soils, the breed distribution areas cover 47 agro-ecological zones.

In the next sections more detail is provided for some key attributes.

3.3.2. Agro-climatic Zones

The agro-climatic zones that occur in the different breed distribution areas are listed in Table 12. The tables with the composition of each breed distribution area in terms of agro-climatic zones are provided in Annex 2. These tables allow to assess which agro-climatic zones are the most important ones for the individual breeds.

In Egypt the agro-climatic zones with the highest representation in the sheep breed areas are 4 and 17, whereas 3,4 and 17 prevail in the goat breed areas. In Iran the most common ACZ is 37, for goats 16.

The prevailing agro-climatic zones in the sheep breed areas of Morocco are 30 and 33, whereas 33 is the main one for the goat breeds.

In Turkey the most common ACZ is 46 for both sheep and goat breeds.

Table 12. Agro-climatic zones of the breed distribution areas

Code	Agroclimatic Zone	Moisture regime	Aridity index	Winter temp.	Tp. Range Winter	Summer temp.	Tp. Range Summer
3	HA-M-VW	Hyper-arid	< 0.03	Mild	10° - 20°C	Very warm	> 30°C
4	HA-M-W	Hyper-arid	< 0.03	Mild	10° - 20°C	Warm	20° - 30°C
6	HA-C-VW	Hyper-arid	< 0.03	Cool	0° - 10°C	Very warm	> 30°C
7	HA-C-W	Hyper-arid	< 0.03	Cool	0° - 10°C	Warm	20° - 30°C
16	A-M-VW	Arid	0.03 - 0.2	Mild	10° - 20°C	Very warm	> 30°C
17	A-M-W	Arid	0.03 - 0.2	Mild	10° - 20°C	Warm	20° - 30°C
19	A-C-VW	Arid	0.03 - 0.2	Cool	0° - 10°C	Very warm	> 30°C
20	A-C-W	Arid	0.03 - 0.2	Cool	0° - 10°C	Warm	20° - 30°C
21	A-C-M	Arid	0.03 - 0.2	Cool	0° - 10°C	Mild	10° - 20°C
24	A-K-W	Arid	0.03 - 0.2	Cold	<= 0°C	Warm	20° - 30°C
25	A-K-M	Arid	0.03 - 0.2	Cold	<= 0°C	Mild	10° - 20°C
29	SA-M-VW	Semi-arid	0.2 - 0.5	Mild	10° - 20°C	Very warm	> 30°C
30	SA-M-W	Semi-arid	0.2 - 0.5	Mild	10° - 20°C	Warm	20° - 30°C
31	SA-M-M	Semi-arid	0.2 - 0.5	Mild	10° - 20°C	Mild	10° - 20°C
32	SA-C-VW	Semi-arid	0.2 - 0.5	Cool	0° - 10°C	Very warm	> 30°C
33	SA-C-W	Semi-arid	0.2 - 0.5	Cool	0° - 10°C	Warm	20° - 30°C
34	SA-C-M	Semi-arid	0.2 - 0.5	Cool	0° - 10°C	Mild	10° - 20°C
37	SA-K-W	Semi-arid	0.2 - 0.5	Cold	<= 0°C	Warm	20° - 30°C
38	SA-K-M	Semi-arid	0.2 - 0.5	Cold	<= 0°C	Mild	10° - 20°C
43	SH-M-W	Sub-humid	0.5 - 0.75	Mild	10° - 20°C	Warm	20° - 30°C
45	SH-C-VW	Sub-humid	0.5 - 0.75	Cool	0° - 10°C	Very warm	> 30°C
46	SH-C-W	Sub-humid	0.5 - 0.75	Cool	0° - 10°C	Warm	20° - 30°C
47	SH-C-M	Sub-humid	0.5 - 0.75	Cool	0° - 10°C	Mild	10° - 20°C
50	SH-K-W	Sub-humid	0.5 - 0.75	Cold	<= 0°C	Warm	20° - 30°C
51	SH-K-M	Sub-humid	0.5 - 0.75	Cold	<= 0°C	Mild	10° - 20°C
52	SH-K-C	Sub-humid	0.5 - 0.75	Cold	<= 0°C	Cool	0° - 10°C
56	H-M-W	Humid	0.75 - 1	Mild	10° - 20°C	Warm	20° - 30°C
59	H-C-W	Humid	0.75 - 1	Cool	0° - 10°C	Warm	20° - 30°C
60	H-C-M	Humid	0.75 - 1	Cool	0° - 10°C	Mild	10° - 20°C
63	H-K-W	Humid	0.75 - 1	Cold	<= 0°C	Warm	20° - 30°C
64	H-K-M	Humid	0.75 - 1	Cold	<= 0°C	Mild	10° - 20°C
65	H-K-C	Humid	0.75 - 1	Cold	<= 0°C	Cool	0° - 10°C
72	PH-C-W	Per-humid	> 1	Cool	0° - 10°C	Warm	20° - 30°C
76	PH-K-W	Per-humid	> 1	Cold	<= 0°C	Warm	20° - 30°C
77	PH-K-M	Per-humid	> 1	Cold	<= 0°C	Mild	10° - 20°C
78	PH-K-C	Per-humid	> 1	Cold	<= 0°C	Cool	0° - 10°C

3.3.3. Soil Management Domains

The Soil Management Domains that occur in the different breed distribution areas are listed in Table 13. Of these the most common ones in Egypt are SMD 00 and 78 for sheep breeds, and SMD 78 for goat breeds. In Iran the dominant soil management domain in the sheep breeds distribution areas is SMD 52, for goat breeds SMD 40 and SMD 88. In Morocco SMD 10 is the most important one in the sheep breed areas, and SMD 10 and SMD 72 in the goat breed areas. In Turkey the most common soil management domains in both sheep and goat breed areas are SMD 00 and SMD 10.

Table 13. Soil management domains of the breed distribution areas

Code	Description
00	Undifferentiated soil management domain
10	Predominantly agricultural soils
11	Miscellaneous soils, with agricultural soils the most important
12	Mainly agricultural soils, associated with soils of wetlands, poorly drained areas and floodplains
15	Mainly agricultural soils, associated with rocky outcrops and shallow soils
16	Mainly agricultural soils, associated with semi-desert soils
18	Mainly agricultural soils, associated with non-agricultural soils
20	Predominantly soils of wetlands, poorly drained areas and floodplains
26	Mainly soils of wetlands, poorly drained areas and floodplains, associated with semi-desert soils
28	Mainly soils of wetlands, poorly drained areas and floodplains, associated with non-agricultural soils
40	Predominantly sodic and saline soils
44	Miscellaneous soils, with sodic and saline soils the most important
50	Predominantly rocky outcrops and shallow soils
56	Mainly rocky outcrops and shallow soils, associated with semi-desert soils
57	Mainly rocky outcrops and shallow soils, associated with desert soils
58	Mainly rocky outcrops and shallow soils, associated with non-agricultural soils
60	Predominantly semi-desert soils
61	Mainly semi-desert soils, associated with agricultural soils
63	Mainly semi-desert soils, associated with sandy soils
64	Mainly semi-desert soils, associated with sodic and saline soils
66	Miscellaneous soils, with semi-desert soils the most important
68	Mainly semi-desert soils, associated with non-agricultural soils
70	Predominantly desert soils
72	Mainly desert soils, associated with soils of wetlands, poorly drained areas and floodplains
75	Mainly desert soils, associated with rocky outcrops and shallow soils
78	Mainly desert soils, associated with non-agricultural soils
80	Predominantly non-agricultural soils
81	Mainly non-agricultural soils, associated with agricultural soils
83	Mainly non-agricultural soils, associated with sandy soils
85	Mainly non-agricultural soils, associated with rocky outcrops and shallow soils
88	Miscellaneous soils, with non-agricultural soils the most important
90	Predominantly soils with high acidity and/or low nutrient status
DS0	Predominantly mobile sands
DS5	Mainly mobile sands, associated with rocky outcrops and shallow soils
DS8	Mainly mobile sands, associated with non-agricultural soils
ST	Salt flats
WR	Water bodies

The tables with the composition of each breed distribution area in terms of soil management domains are provided in Annex 2.

3.3.4. Agro-ecological zones

The agro-ecological zones that occur in the different breed distribution areas are listed in Table 14. An 'X' mark indicates in which of the four countries the particular zones occur.

Table 14. Agro-ecological zones of the breed distribution areas

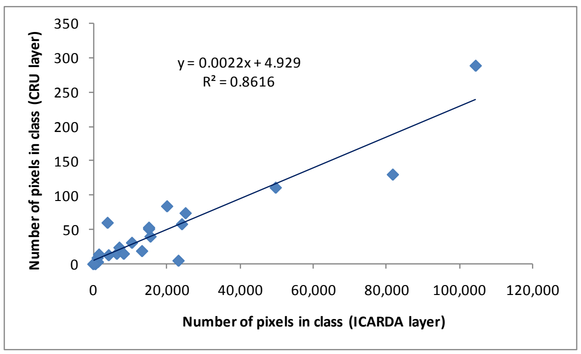
AEZ	Egypt	Iran	Morocco	Turkey	Agroclimatic zones	Land use	Landform
110	X	X			Hyper-arid climates with mostly warm or very warm summers and warm or mild winters	Irrigated crops	Undifferentiated
131	X	X	X			Non-agricultural land	Plains and plateaux
132	X	X	X			Non-agricultural land	Hills
133	X					Non-agricultural land	Mountains
210	X	X	X		Arid climates with mild or warm winters and warm or very warm summers; winter coldness is not an ecological constraint	Irrigated crops	Undifferentiated
221			X			Rainfed crops	Plains and plateaux
222			X			Rainfed crops	Hills
231	X		X			Non-agricultural land	Plains and plateaux
232			X			Non-agricultural land	Hills
310		X	X		Arid climates with cool or cold winters and warm or very warm summers; winter coldness is an ecological constraint	Irrigated crops	Undifferentiated
321		X	X	X		Rainfed crops	Plains and plateaux
322		X				Rainfed crops	Hills
331		X	X	X		Non-agricultural land	Plains and plateaux
332	X	X	X	X		Non-agricultural land	Hills
333		X	X			Non-agricultural land	Mountains
410			X	X	Semi-arid climates with mild or warm winters and warm or very warm summers; winter coldness is not an ecological constraint	Irrigated crops	Undifferentiated
421			X			Rainfed crops	Plains and plateaux
431			X			Non-agricultural land	Plains and plateaux
432			X			Non-agricultural land	Hills
510		X		X	Semi-arid climates with cool or cold winters and mostly warm summers; winter coldness is an ecological constraint	Irrigated crops	Undifferentiated
521		X	X	X		Rainfed crops	Plains and plateaux
522		X	X	X		Rainfed crops	Hills
523		X		X		Rainfed crops	Mountains
531		X	X	X		Non-agricultural land	Plains and plateaux
532		X	X	X		Non-agricultural land	Hills
533		X	X	X		Non-agricultural land	Mountains
610		X		X	Mostly semi-arid climates with mostly cold winters and mild summers; winter coldness is an ecological constraint as well as short thermal growing periods	Irrigated crops	Undifferentiated
621				X		Rainfed crops	Plains and plateaux
622		X		X		Rainfed crops	Hills
623		X		X		Rainfed crops	Mountains
631		X		X		Non-agricultural land	Plains and plateaux
632		X		X		Non-agricultural land	Hills
633		X		X		Non-agricultural land	Mountains
810		X		X	Sub-humid climates with cool or cold winters and mild or warm summers; winter coldness is an ecological constraint	Irrigated crops	Undifferentiated
822				X		Rainfed crops	Hills
823				X		Rainfed crops	Mountains
831				X		Non-agricultural land	Plains and plateaux
832		X		X		Non-agricultural land	Hills
833		X		X		Non-agricultural land	Mountains
1010		X		X	Humid climates with cool or cold winters and mild or warm summers; winter coldness is an ecological constraint	Irrigated crops	Undifferentiated
1022				X		Rainfed crops	Hills
1032				X		Non-agricultural land	Hills
1033				X		Non-agricultural land	Mountains
1310		X		X	Per-humid climates with mild or warm winters and summers; winter coldness is not an ecological constraint	Irrigated crops	Undifferentiated
1331		X				Non-agricultural land	Plains and plateaux
1332				X		Non-agricultural land	Hills
1333				X		Non-agricultural land	Mountains

In Egypt the dominant agro-ecological zone is 131 in both sheep and goat breed areas. In Iran the dominant agro-ecological zones are 331 and 332 in the sheep breed areas and 231 and 232 in the goat breed areas, indicating a general climatic differentiation with sheep in the wetter and goats in the drier areas. This is also the case in Morocco, where the dominant agroecological zone in the sheep breed areas is 532 and AEZ 332 is most common in the goat breed areas. In Turkey AEZ 532 is the most common one in both sheep and goat breed areas.
The tables with the composition of each breed distribution area in terms of agro-ecological zones domains are provided in Annex 2.

3.3.5. Effect of input spatial data on characterization results

3.3.5.1. Comparison of CRU and ICARDA climate layers

The visual similarity in the patterns of the three thematic layers (annual precipitation, maximum temperature of the warmest month and minimum temperature of the coldest month) between the CRU and ICARDA datasets is remarkable (Figs. 16-21). This is also evidenced by making a direct correlation between the number of pixels in each thematic class for both the CRU and ICARDA layers, as shown in the example of maximum temperature for the sheep and goat breeds of Egypt (Fig. 14).



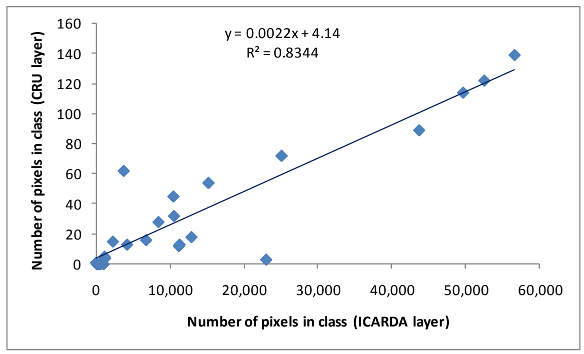


Figure 14. Correlations between pixels in each thematic class of the maximum temperature of the warmest month for sheep breeds (left) and goat breeds (right) of Egypt

The difference tables between the two datasets (Tables 81-103) indicate for some breeds a tendency to occupy a higher percentage of the extreme classes (low or high precipitation, low or high temperature) in the high-resolution maps as compared to the low-resolution CRU layers; for others this tendency is not visible. Temperature is strongly correlated with elevation, precipitation to a lesser but still significant extent as well. As they are constructed on a fine-grid digital elevation model platform, the high-resolution climatic maps are much more able than the CRU layers to capture these linkages with topography and to identify smaller ecological niches (see also 3.3.5.2), which may be important sources of breed adaptability.

The effect of difference in spatial resolution becomes more clear when comparing the percentages in each thematic class between the low-resolution CRU layers and the high-resolution ICARDA layers. As shown in the example of annual precipitation classes for the animal breeds of Turkey (Fig. 15), the predictive power of the regression equation is very low.

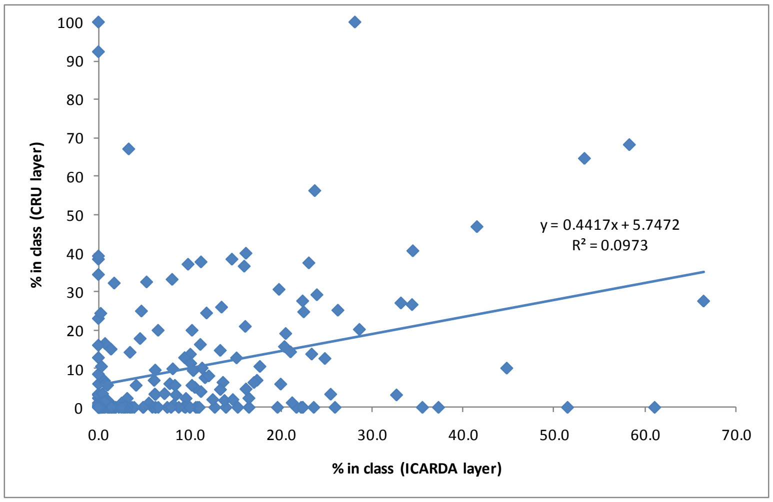


Figure 15. Correlation between the percentages in each thematic class of the annual precipitation for sheep breeds of Turkey

3.3.5.2. Climates according to Köppen

The two Köppen maps (Figs. 22-23) for Iran show very contrasting patterns, which are due (i) to differences in the depth of the classification (the high-resolution Köppen map contains twice as many (16) classes as the low-resolution map)and (ii) to different methodologies . The high-resolution map shows a very clear pattern linked to elevation differences, which is to be expected. However, in the low-resolution map this linkage is entirely lost. Even after correlation of the two classifications has resulted into a common legend (Table 15), the differences in the areas that occur in each climate class are very large between the two maps. Tables 93-95 indicate that for the sheep breeds of Iran 62 times the difference in class areas between the Peel and ICARDA maps exceeds 20%, which is 2-3 times more than for the corresponding differences in class areas between the CRU and ICARDA climate maps. Again, this is not surprising as the Peel map was designed for exploratory assessments at global scale. It is therefore entirely unsuitable for characterization of relatively small breed distribution areas.

Table 15. Levels of the Köppen classification for Iran used in the Peel et al.2007 and ICARDA layers

Peel et al., 2007		ICARDA	
Symbol	Description	Symbol	Description
BWh	Hot arid desert climate	BWwh	Hot arid (desert) climate, winter precipitation
BWk	Cold arid desert climate	BWwk	Cool arid (desert) climate, winter precipitation
		BWwk'	Cold arid (desert) climate, winter precipitation
BSh	Hot arid steppe climate	BSwh	Hot semi-arid (steppe) climate, winter precipitation
BSk	Cold arid steppe climate	BS0k	Cool semi-arid (steppe) climate, neither winter nor summer drought
		BSwk	Cool semi-arid (steppe) climate, winter precipitation
		BSwk'	Cold semi-arid (steppe) climate, winter precipitation
Csa	Temperate climate with hot summer	Csa	Warm temperate rainy climate with dry and hot summers
		Csb	Warm temperate rainy climate with dry and warm summers
Cfa	Temperate climate without dry season and with hot summer	Csa	Warm temperate rainy climate without dry season and hot summers
		Csb	Warm temperate rainy climate without dry season and warm summers
Dsa	Cold climate with dry and hot summer	Dsa	Subarctic climate with humid winter and hot summer
		Dsb	Subarctic climate with humid winter and warm summer
Dfa	Cold climate without dry season and with hot summer	Dfa	Continuously humid subarctic climate with hot summer
		Dfb	Continuously humid subarctic climate with warm summer
	No equivalent	E	Arctic climate

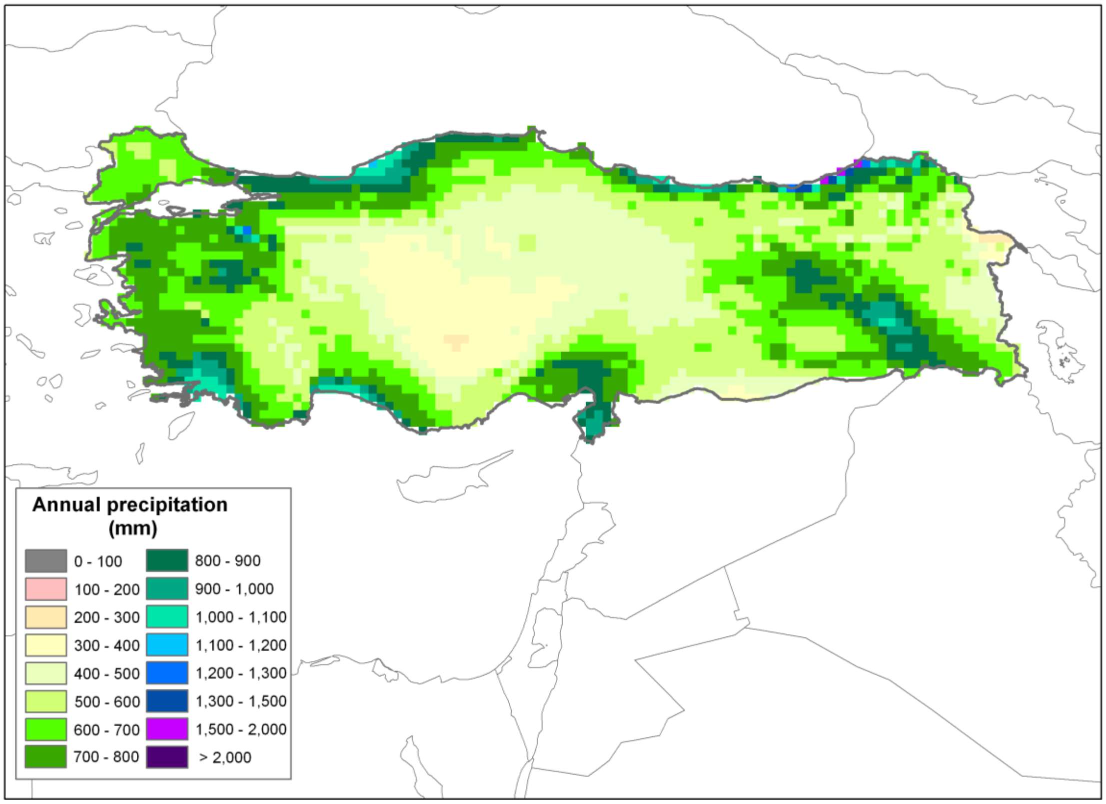


Figure 16. Mean annual precipitation in Turkey (CRU layer)

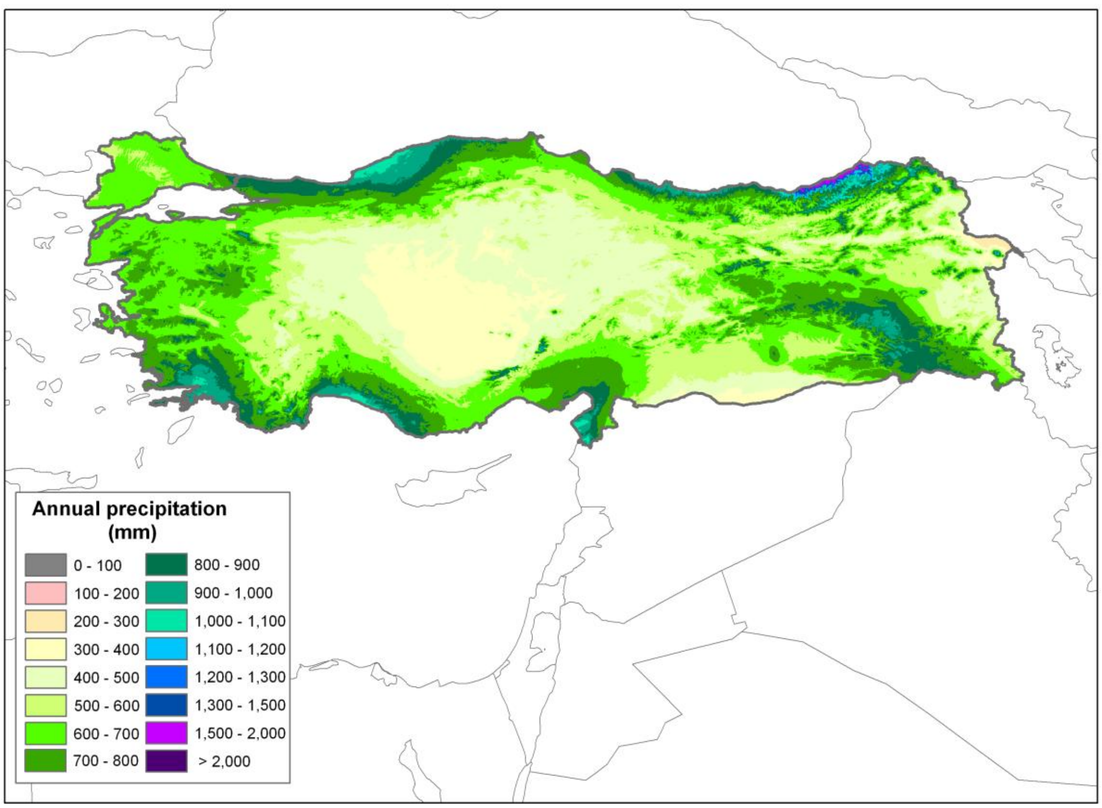


Figure 17. Mean annual precipitation in Turkey (ICARDA layer)

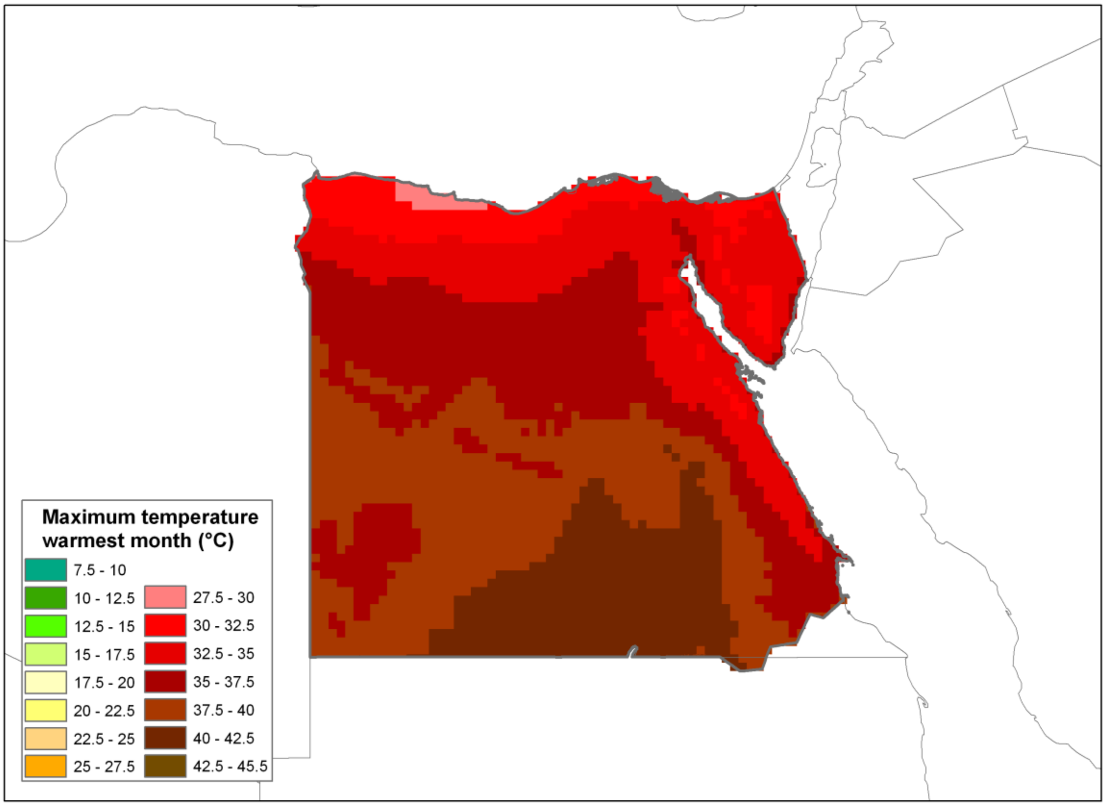


Figure 18. Maximum temperature of the warmest month in Egypt (CRU layer)

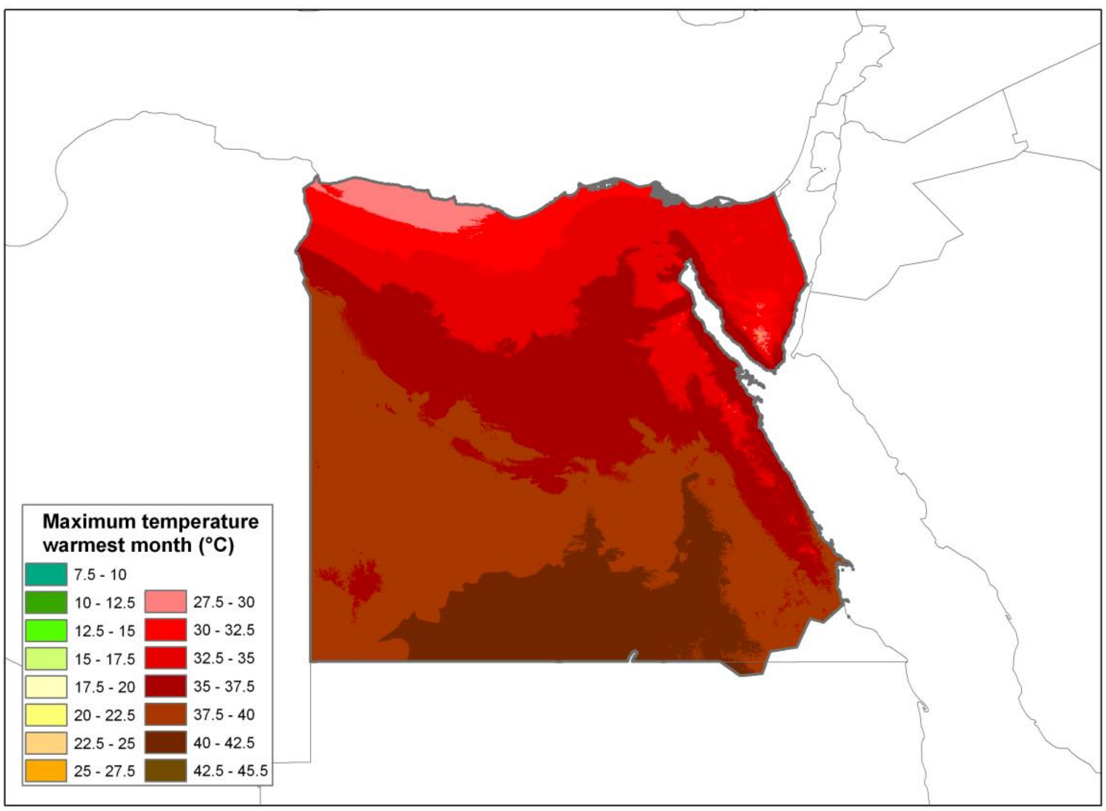


Figure 19. Maximum temperature of the warmest month in Egypt (ICARDA layer)

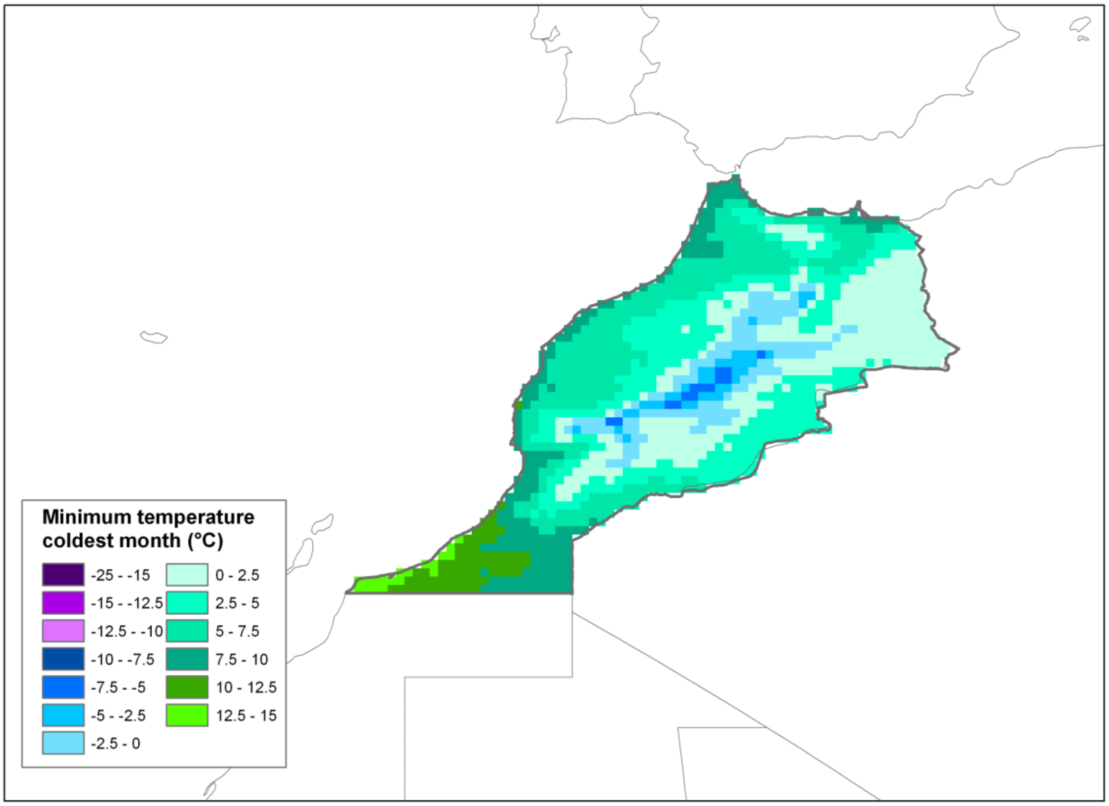


Figure 20. Minimum temperature of the coldest month in Morocco (CRU layer)

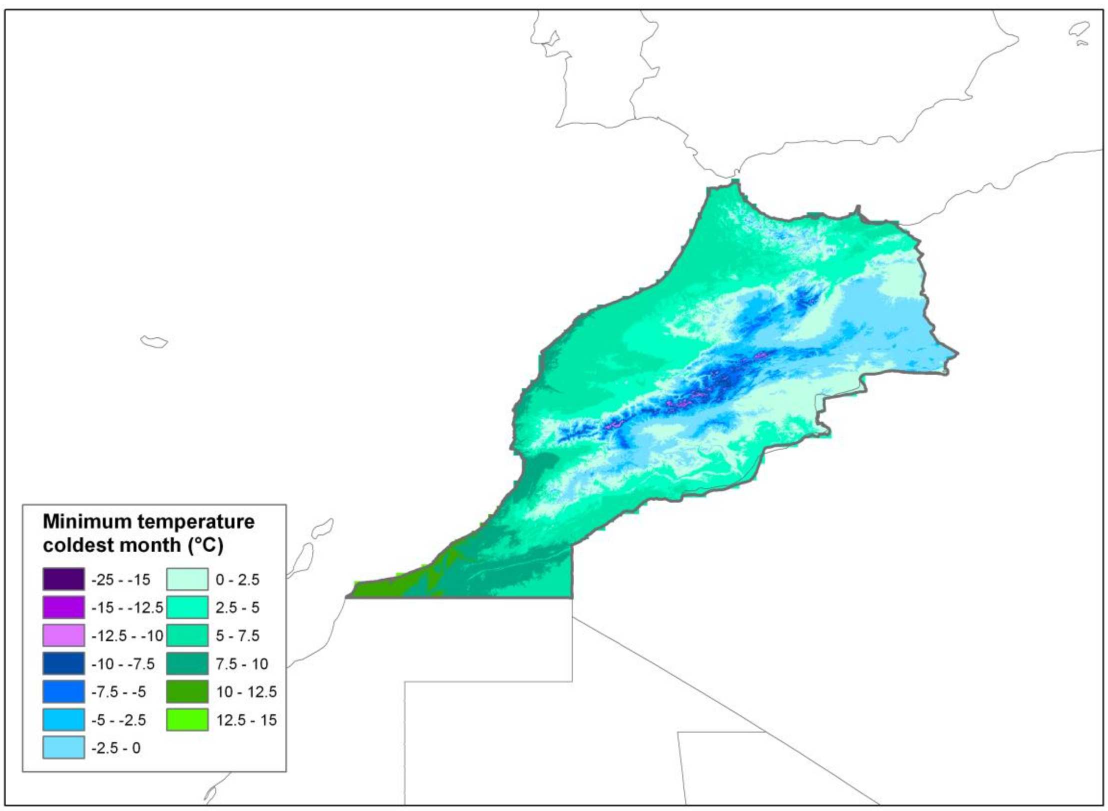


Figure 21. Minimum temperature of the coldest month in Morocco (ICARDA layer)

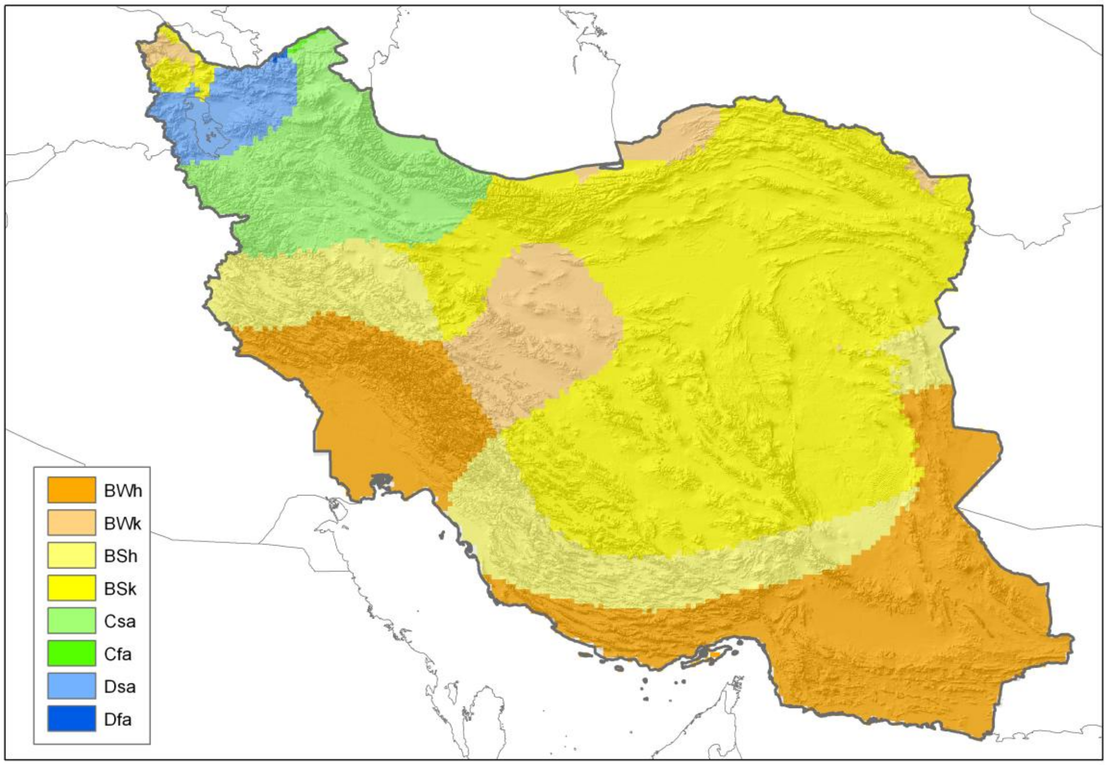


Figure 22. Köppen climatic zones in Iran (Peel et al., 2007)

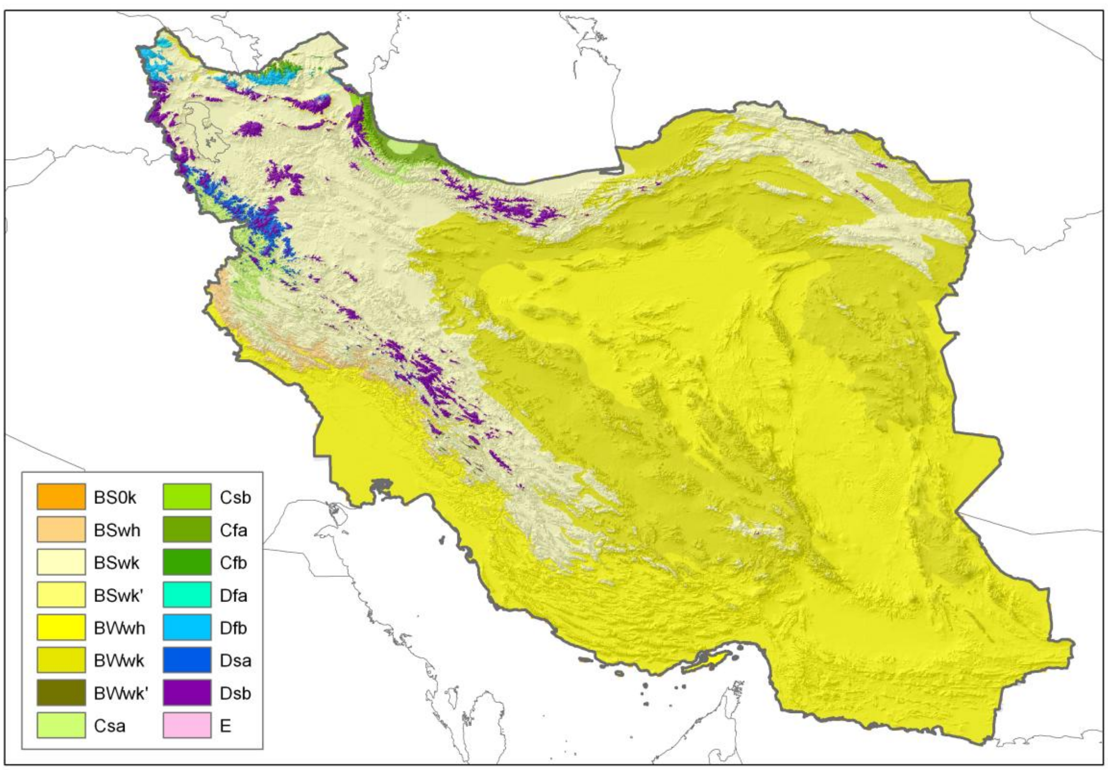


Figure 23. Köppen climatic zones in Iran (ICARDA layer)

3.4. IDENTIFICATION OF AGRICULTURAL ENVIRONMENTS WITH HIGH SIMILARITY TO THE SELECTED BREED DISTRIBUTION AREAS

As mentioned in the Methodology chapter, the identification of areas that are similar to the current breed distribution areas is a key approach for identifying areas with a physical potential for introducing these breeds. Obviously similarity in biophysical environment is not a sufficient predictor for the success of introduction outside the current breed area, but it can be an important one, particularly if the breed is not sheltered and has to thrive on what the environment provides for a major part of the year. The tool used was the *similarity index*, which can be applied to different components of the natural environment, and which was applied in this study to assess similarity in temperature, precipitation, landforms and soil patterns.

In this section some maps are provided to give an idea of the emerging patterns and to visualize how each of the assessed themes either contributes or restricts that physical potential. These maps can be used in isolation or combined, depending on what are the critical factors determining the natural adaptation possibilities of particular breeds.
The breed selected as example for this chapter was the Dagliç sheep from Turkey. All evaluated breed similarity maps are to be found on-line on the FTP site.

For all breeds we find that at the global scale temperature similarity (Fig. 24) is higher than precipitation similarity (Fig. 25). One reason for this is that all breeds occur in climates with more or less pronounced Mediterranean character, and these are 'minority' climates at the global scale. Landform similarity is usually high at global scale; in the case of the Dagliç sheep breed (Fig. 26) this is less the case because the breed is an dweller of hilly and mountainous areas, the latter being a minority landform at the global scale. The soil similarity patterns may vary considerably between breeds, depending on the size of the area they occupy and the resulting complexity and uniqueness of the soil patterns: the more generic these soil patterns are, the more likely they are to occur elsewhere. In the case of Dagliç (Fig. 27), areas of high soil similarity occur all over the globe for the simple reason that the breed area consists mainly of a combination of agricultural and non-differentiated soils, a combination that can be found in many locations of the world.
In the final map (Fig. 28) which shows similarity with all evaluated components of the natural environment the effect of the 'law of the most limiting factor' is clearly visible: the overall similarity can never be higher than the lowest of the evaluated similarity indices.

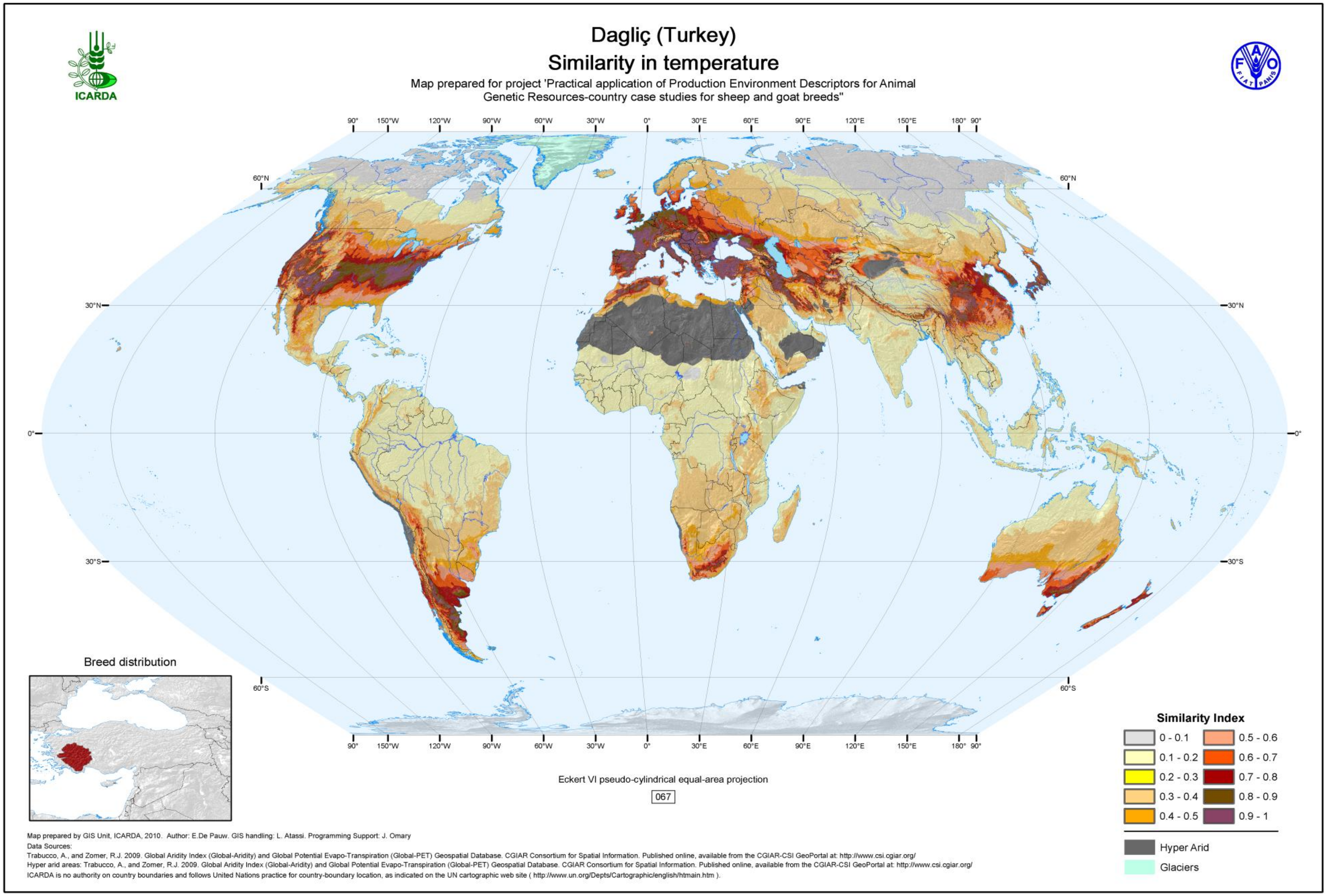


Figure 24. Global temperature similarity with the breed distribution area of Dagliç sheep, Turkey

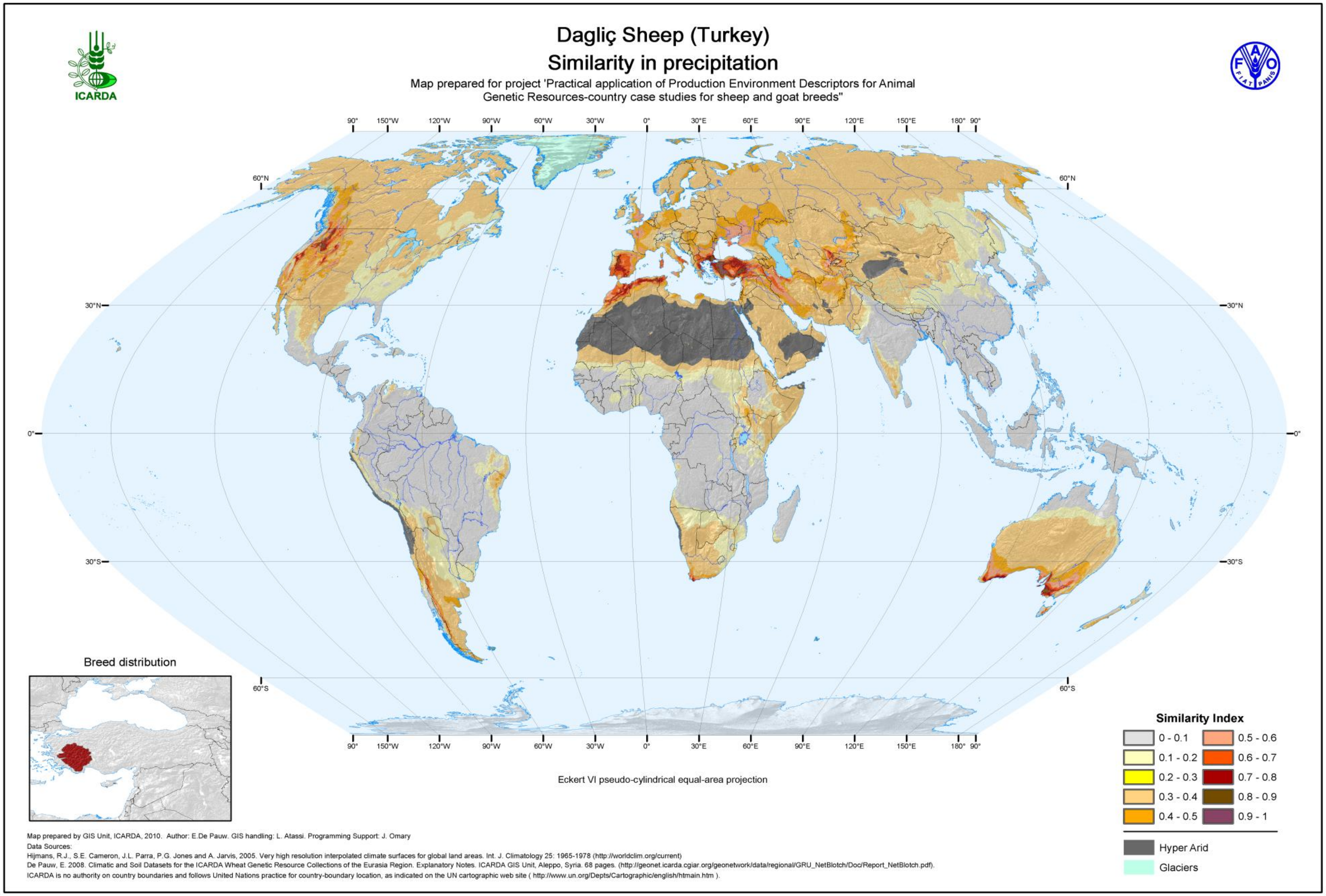


Figure 25. Global precipitation similarity with the breed distribution area of Dagliç sheep, Turkey

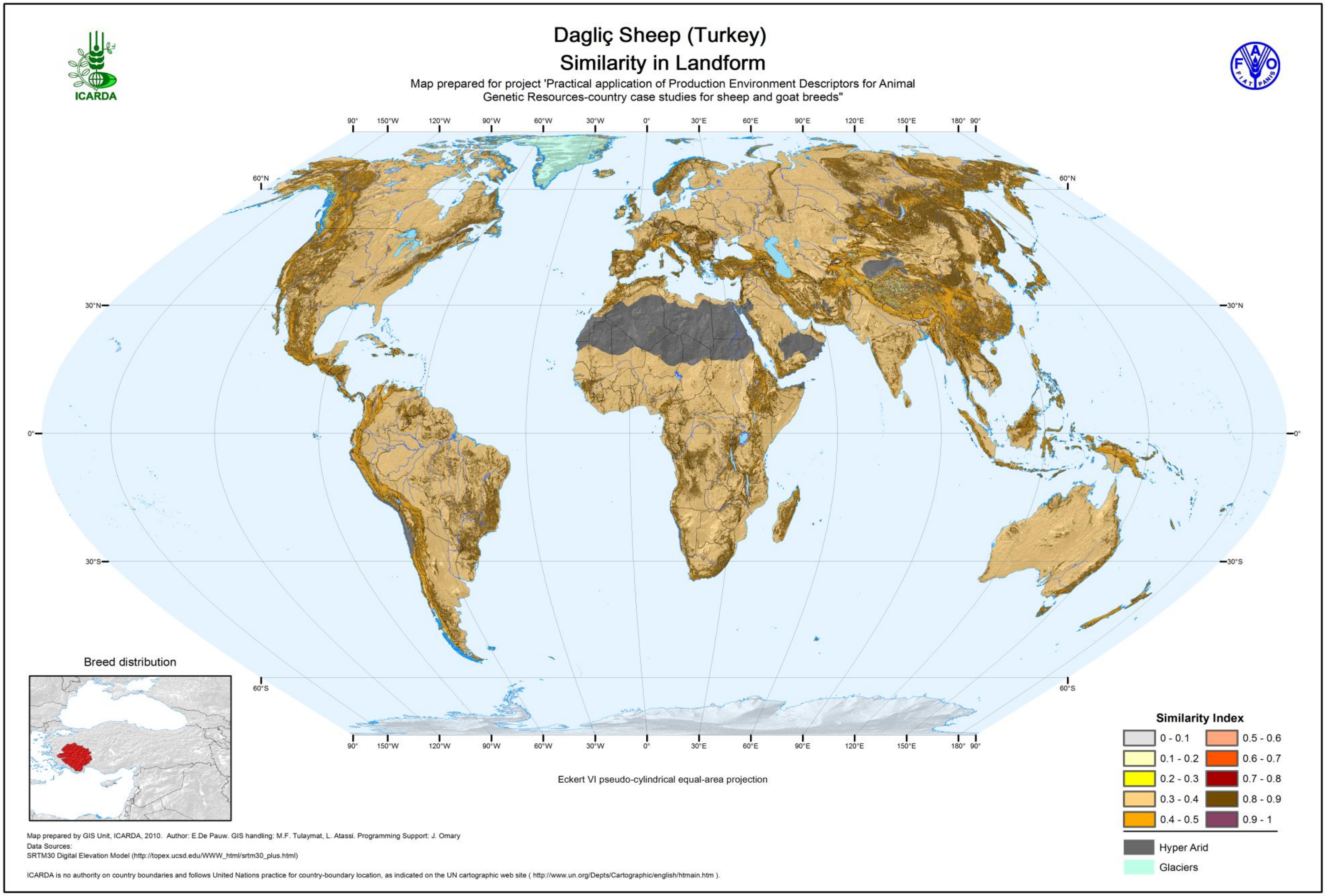


Figure 26. Global landform similarity with the breed distribution area of Dagliç sheep, Turkey

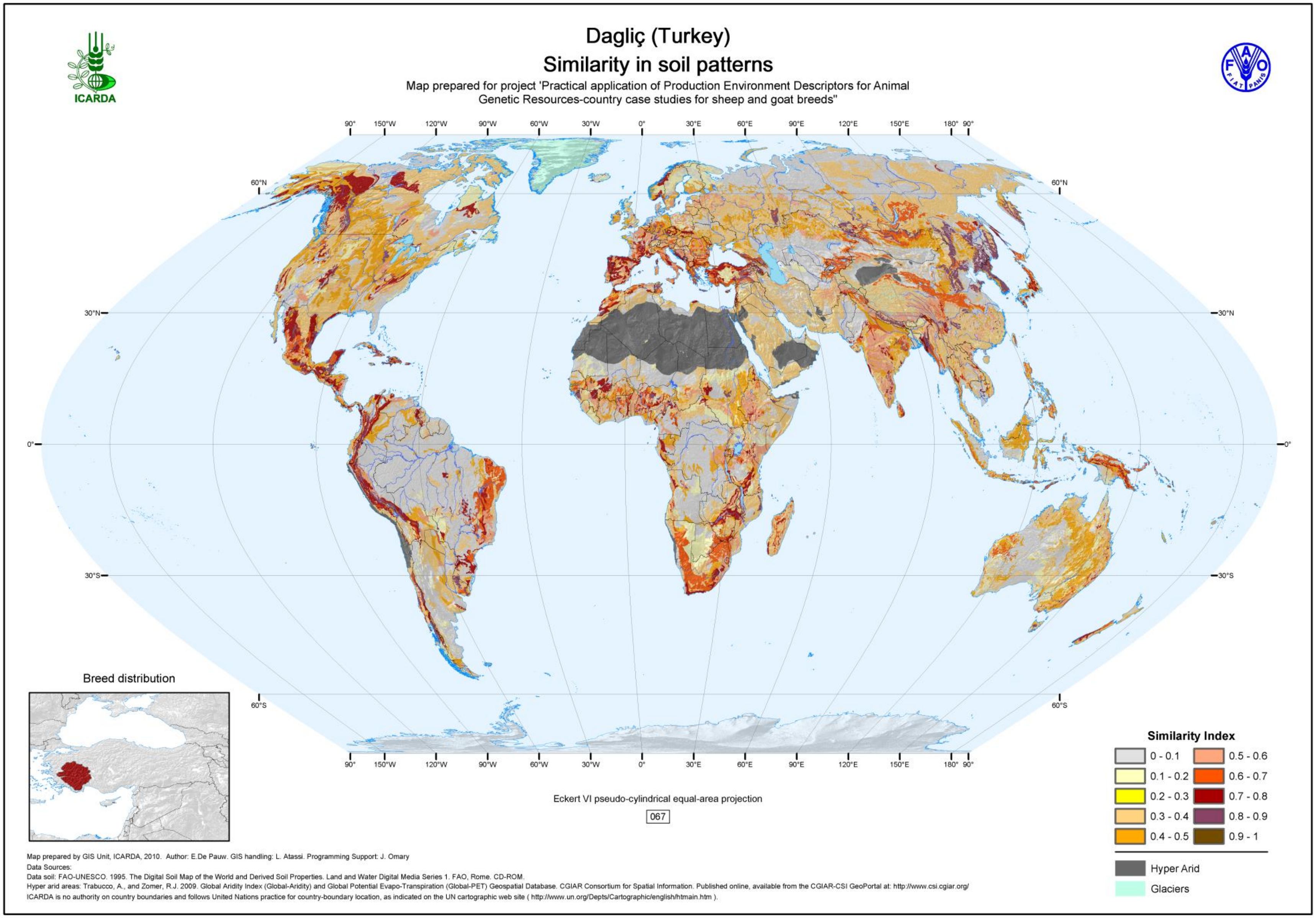


Figure 27. Global soil pattern similarity with the breed distribution area of Dagliç sheep, Turkey

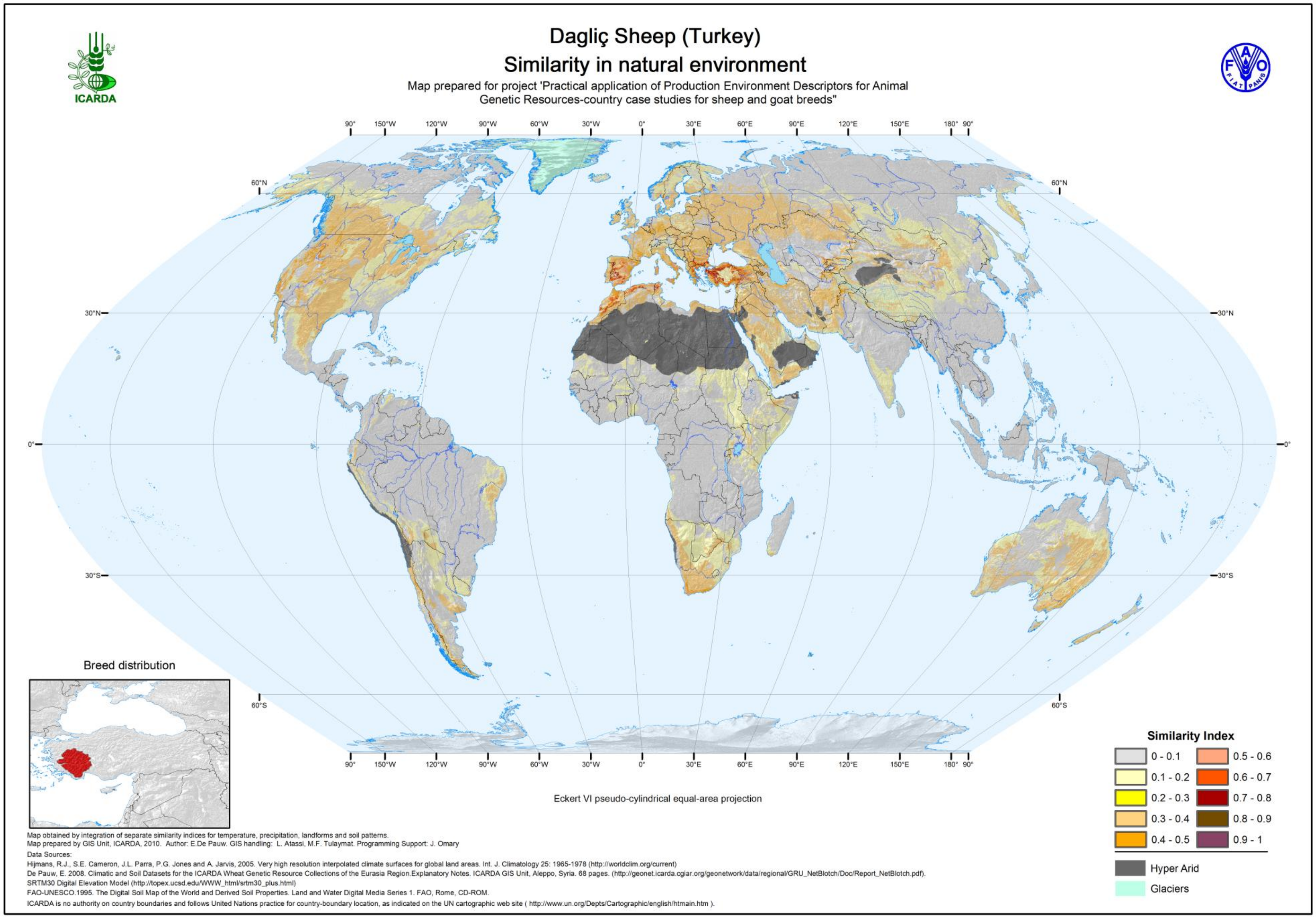


Figure 28. Global similarity in climate, landforms and soils with the breed distribution area of Dagliç sheep, Turkey

4. DISCUSSION AND CONCLUSIONS

4.1. NEW APPROACHES FOR IMPROVING THE PEDS METHODOLOGY

The DAD-IS is a very comprehensive system for the characterization of indigenous animal breeds and therefore an important tool for recording and monitoring animal genetic diversity at global scale. The new PEDS module to be implemented in DAD-IS will allow for a relatively detailed characterization of the breed production environments in terms of natural environment and management environment descriptions. However, in terms of characterizing the distribution areas of these breeds it is to be considered a work in progress. The new description format requires assigning an **average** value to some key attributes of the natural environment of the entire breed area, this way the variations in space and time within the breed area and the internal complementarities of environments may get masked. There is also a high risk of erroneous estimation of values (e.g. temperature, precipitation) if no observing station occurs inside or in the neighborhood of the breed area, if the station is not representative of the breed area, if the breed area is too large to be represented by a single station, or if station data (particularly for climate) are only accessible against payment, in which case they will most likely not be used.

The GIS-based approaches used in this study can help, not only to overcome these limitations but also to extend the role of DAD-IS. These approaches may assist in particular with three of the eight potential areas of analysis identified by the PEDS Workshop report (FAO/WAAP, 2008):

- exploratory spatial data analysis
- analysis of agrobiodiversity
- assessing breed suitability for a specific production environment.

The approaches used, ranging from the very simple to complex, were:

- assisting national coordinators, or their representatives, with maps
- use of national or international spatial data for the characterization of the breed environments
- identifying potential new areas for introduction of breeds

4.1.1. Provision of maps

This modest support proved to be a crucial one. The experience from this pilot project is that the even the best livestock experts can only provide approximations to the real boundaries of breed distribution areas. Therefore collaborators call for good-quality road maps or topographic maps at national scale to guide them in drawing the boundaries. The latter will obviously be drawn more accurately if the collaborators can relate breeds to locations that they know and are able to visualize the spatial geometry between these locations. On these maps there are also other important clues that help draw boundaries, such roads, rivers, lakes and a background suggesting the presence of hills or mountains.
For all pilot countries we were able to identify good-quality road maps, available in travel shops in Europe, on which the collaborators drew the boundaries without particular difficulties.
Whether the maps were in digital or paper format was not important. In all cases the maps were scanned and provided as both digital and paper copies. Most collaborators preferred paper copies and returned paper copies with the boundaries drawn on them. One collaborator used a paint program to draw boundaries on a digital copy and returned a digital map. After the breed area maps were returned

as either paper or digital maps, in all cases they had to be geo-referenced and digitizing before they could be used for further analysis and processing in GIS software.
If DAD-IS data-entry will be based on an *electronic* mapping tool, it is important that the tool includes an adequate base map that contains at least some of the above features to assist orientation.

4.1.2. Use of spatial data for the characterization of breed environments

By overlaying the distribution areas with relevant thematic layers for characterization, optimal use can be made of available spatial data. In this study we used for the characterization of breed environments annual precipitation, landforms, land use/land cover, agro-climatic zones, soil management domains, and agro-ecological zones. However, any spatial theme could be used (e.g. elevation, biomass, desertification) originating from existing maps, digital elevation models or remote sensing.
In all cases the use of spatial datasets for characterization should be governed by simple principles of quality, relevance, and appropriate scale.
The overlaying of a breed distribution area with a spatial dataset can result in a new thematic map for the area. To avoid an inflation of maps at the risk of losing the overview, one very useful technique is to create summaries using a *zonal histogram* approach, in which the breed area is characterized in terms of the percentage occurrence of particular thematic classes. This technique, available in major GIS software packages, has been used to generate the tables 21-80.

4.1.3. Identifying potential new areas for introduction of breeds through similarity mapping

The similarity mapping technique is a very useful general-purpose tool for assessing the likeness between one location and another. Its main advantage is that by using an index approach it assesses the relationship between two locations on a continuous scale and therefore avoids classification traps (such as a 100-150 mm range in annual precipitation is considered similar, and 99 mm or 151 mm as not being similar). In this study key breed environmental characteristics were evaluated through their own similarity index approaches, depending on whether they are continuous variables (e.g. temperature, precipitation), discrete variables (e.g. landform classes) or complex variables (e.g. soil patterns). In this study 4 thematic similarity maps (temperature, precipitation, landforms and soil patterns) were integrated into a single environmental similarity map using the 'most limiting factor' approach.
The same similarity approach can be extended to other relevant environmental characteristics, such as relative humidity, biomass and others, if the required spatial input data existed or could be generated at an appropriate spatial resolution. One could also assign weights to individual themes or simply omit some if considered irrelevant to particular breeds or target areas.

As is the case with all spatial data used for the characterization of breed areas, the similarity maps can be summarized in synthesis tables using the zonal histogram functions in GIS software. An example is given in Table 16 in which the percentages are given for different countries of the environmental similarity classes. Such tables can be prepared for different breeds and target areas with similarity classes as wide or narrow as relevant, thus allowing comparison between different breeds in terms of potential adaptation to a new target area.

By assuming that adaptation has occurred in the distribution areas, similarity mapping can thus be used as an exploratory tool for identifying new areas where adaptation is likely. However, s*imilarity* is not the same concept as *suitability*. Similarity mapping quantifies how well two environments match and is therefore independent of the characteristics of the entities that occur in these areas, whether they are crops or animals. On the other hand, mapping suitability is a more involved process which requires detailed knowledge of the environmental requirements of individual crops, cultivars or livestock breeds. Case studies should be introduced to assess the feasibility of suitability mapping for individual breeds in specific target areas.

Table 16. Anatolian Merino sheep: percent of each country in different environmental similarity classes

	Environmental similarity index						
Country	0-0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.5	0.5-0.6	0.6-0.7
KAZAKHSTAN	77	7	1	7	8	1	0
UZBEKISTAN	81	5	0	0	14	0	0
GEORGIA	53	45	1	0	0	0	0
KYRGYZSTAN	15	76	0	1	8	0	0
TURKMENISTAN	77	5	0	1	16	0	0
TURKEY	9	61	4	3	2	6	16
AZERBAIJAN	13	37	1	1	26	18	5
ARMENIA	23	75	0	0	0	0	2
TAJIKISTAN	37	49	1	1	11	1	0
AFGHANISTAN	30	53	1	4	12	0	0
TUNISIA	52	25	7	15	1	0	0
SYRIA	9	38	13	24	10	5	0
PAKISTAN	47	51	1	0	0	0	0
ALGERIA	86	10	1	0	1	1	1
IRAN	29	58	1	1	2	6	2
MOROCCO	11	32	30	10	6	9	3
SPAIN	47	43	0	4	0	0	6
CYPRUS	26	61	12	1	0	0	1
LEBANON	50	41	6	2	1	0	0
JORDAN	23	4	64	1	7	2	0
ISRAEL	57	35	6	2	0	0	0
LIBYA	38	54	6	2	0	0	0

The focus on soils introduced in this study is potentially a good start for bringing in more soilfeatures in the PEDS methodology. Whereas currently only some soil properties are taken into consideration (pH, stoniness, flooding or poor drainage), other soil properties are to be considered as well, not just as characteristics of the terrain, but more generally as possible indicators of the nutritive value of biomass growing on different soil types. A global map of soil management domains would be a useful addition to the suite of spatial data available for incorporation in DAD-IS.

4.2. LIMITATIONS

4.2.1. Usefulness of the data collected from the questionnaires

The question addressing the number of production environments (PE) for a certain breed did not yield useful responses. For example, in some cases our collaborators stated that the breed was kept in more than one PE, but then reported that 100% of the breed was kept in the PE described in the questionnaire, which means that the question was not well understood. Furthermore, it is not very probable that the NCs would be willing to fill more than one questionnaire for each breed, thus a possibility would be to add a text field after the question of what percentage of the breed is kept in the main PE. If the response to the question is less than 100%, the NC could briefly explain the other PEs where the breed is kept in the text field.

When the breed belonged to a transhumant system, it was not clear which part of the transhumant system should be described by environment and management factors, such as confinement, climate modifier, restriction in watering and feeding. Thus, a text field should be added in the questionnaire to describe the components of the transhumant system and both parts of the system should be described.

A difficulty for all collaborators was to enter information on disease challenges and treatments as most of the collaborators are breeders and do not have the required knowledge. This limitation may in fact be the case for the majority of the National Coordinators in FAO's network. In the current study disease challenges were reported only by Morocco and Egypt. In Egypt there was no differentiation in the disease challenge for the different production environments, while in Morocco there was a difference in occurrence of mastitis and in the frequency of sheep/goat pox between the PEs. The prevalence of diseases is clearly location-bound information. Thus, it would probably be much easier to obtain information on the disease challenge for the country as a whole (smaller countries), or for distinct agroecosystems within a certain country, from veterinary departments or national veterinary research centers in the countries. This information could then be used to generate digital maps of disease prevalence that can be overlaid with breed distribution maps.

The information collected on market orientation and on markets targeted varies very little between breeds and even within the countries. The same applies to decision making and work sharing that are not breed but culture and system specific; furthermore it is doubtful if the NCs have realistic/proven information about these aspects.

Based on these observations it is recommended to shorten and sharpen the questionnaires to focus on the breed specific information and for example collect the market and gender related information by species with the exception of the question on niche products. The longer the questionnaire, the more the NCs may have to fill in the same information over and over again, and the less likely it becomes that they will complete the exercise for all species and breeds.

4.2.2. Accessibility to country-level data environmental datasets

In most countries of the world many information sources do exist at national level that could be used for preparing spatially explicit data of relevance for PEDS. There are certainly data gaps, data could be incomplete, of low resolution, somewhat outdated, but even with such limitations national datasets are extremely useful for PEDS. Many countries in the world maintain a policy that the output of institutions paid by public funds should be accessible to the public. However, the key constraint in all pilot countries remains *accessibility* to these data sources, particularly on climate, soils and land use. Accessibility constraints arise principally from concerns about national security or income generation for underfunded custodian institutions. In this respect the pilot countries are certainly representative for the Near East.

Fortunately in the international domain there are several global or regional data sources that are perfectly adequate for the characterization of the natural production environment of the breed distribution areas. This is most certainly the case for the characterization of the terrain, and to a somewhat lesser extent of key attributes of climate, particularly temperature. However, spatial data on soils are approximate and for land use/land cover they are of varying quality. For the latter two natural resource themes there exist no good substitutes for national data. Nevertheless, the use of more general data from international sources is already an improvement above no use at all.

4.3. NEW DATASETS FOR PEDS AND DAD-IS

Section 3.3.5.of this report has demonstrated that a general correspondence exists in the spatial patterns of climatic variables that exist in both low-resolution form (the CRU layers, currently considered as production environment descriptors) and in high-resolution form. However, and unsurprisingly, that good correspondence breaks down at the level of the breed distribution areas as major differences in the composition of these breed areas in terms of climatic classes were observed. This was particularly noticeable in the case of the integrated climatic variables, of which the Köppen climatic zoning was a typical example (section 3.3.5.2).

Therefore there is definitely a case to be made for including in DAD-IS layers that are *high-resolution*. The 30-arc-second , or '1-km' resolution (although in reality the pixels are even smaller), is an excellent compromise between accuracy and size/unwieldiness of the resulting data layers. ICARDA does not have global climate data layers but the latter certainly exist as public good. Excellent global datasets in this respect are provided by Hijmans et al. (2005).

The characterization of the breed areas can also benefit by making use of integrated environmental variables, such as agro-climatic zones, soil management domains and agro-ecological zones, which have been used in this report. While currently they have only been mapped at a regional scale, *the mapping of these variables can easily be extended to global level with a minimal investment*.
The *agro-climatic zones*, mapped as an extension of the UNESCO system (1979), allow for a better differentiation and characterization of climatic conditions in breed areas than the Köppen system, because they are based on an elementary waterbalance, comparing precipitation input with evapotranspiration losses.
The *soil management domains* concept is very useful for DAD-IS because its focus is on management properties of soils, and indirectly provides clues to biomass productivity and quality for livestock feed in different regions. Thus it allows a new interpretation of a global soil taxonomic association map (FAO-UNESCO, 1995) that can be useful to livestock management.
The *agro-ecological zones* concept is based on the overlaying and simplification of some of the above themes (agroclimatic zones, soil management domains) combined with landform and land use/land cover, which are the key themes. The integrated nature of this concept allows to compress much information about the biophysical environment into a single variable.

REFERENCES

D. Celis, E. De Pauw and R. Geerken. 2007. Assessment of land cover/ land use in the CWANA region using AVHRR imagery and agro-climatic data. Part 1. Land Cover/Land Use - base year 1993. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria, vi+ 54 pp. ISBN 92-9127-192-4

De Pauw, E. 2002. An agro-ecological exploration of the Arabian Peninsula. ICARDA, Aleppo, Syria, 77 pp. ISBN 92-9127-119-5.

De Pauw, E. 2008. Climatic and Soil Datasets for the ICARDA Wheat Genetic Resource Collections of the Eurasia Region. Explanatory Notes. ICARDA GIS Unit, Aleppo, Syria. 68 pages.

E. De Pauw. 2010. Agro-ecological zoning of the CWANA region. In A. El-Beltagy and M.C. Saxena (Eds.). Sustainable Development in Drylands – Meeting the Challenge of Global Climate Change. Proceedings of the Ninth International Conference on Development of Drylands, 7-10 November 2008, pp. 335-348, International Drylands Development Commission, ICARDA.

E. De Pauw, A. Mirghasemi, A. Ghaffari, B. Nseir. 2008. Agro-ecological zones of Karkheh River Basin. ICARDA, Aleppo, Syria. viii+96 pp. ISBN: 92-9127-212-6

Doorenbos J. and Pruitt W.O. (1984). Guidelines for predicting crop water requirements. FAO Irrigation and Drainage Paper 24, FAO, Rome

FAO/WAAP. 2008. Report of the FAO/WAAP Workshop on Production Environment Descriptors for Animal Genetic Resources, held Caprarola, Italy, 6-8 May 2008. Edited by D. Pilling, B. Rischkowsky & B.D. Scherf. 2008, Rome, 103 pp.http://dad.fao.org/cgi-bin/getblob.cgi?sid=-1,593

FAO-UNESCO.1995. The Digital Soil Map of the World and Derived Soil Properties. Land and Water Digital Media Series 1. FAO, Rome, CD-ROM.

Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. Int. J. Climatology 25: 1965-1978 (http://worldclim.org/current)

Hutchinson, M.F. 1995. Interpolating mean rainfall using thin plate smoothing splines. Int. J. Geogr. Info. Systems 9: 385-403.

Hutchinson, M.F. 2000. ANUSPLIN version 4.1. User Guide. Center for Resource and Environmental Studies, Australian National University, Canberra.
On-line document: http://cres.anu.edu.au

Iñiguez, L. (ed.) 2005. Characterization of small ruminant breeds in West Asia and North Africa.Vol.I. West Asia and Vol. II.North Africa. ICARDA, Aleppo, Syria.

Peel, M.C., Finlayson, B.L. & McMahon, T.A. 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and Earth System Sciences, 11: 1633-1644

Sutherst, R.W. 1999. CLIMEX: predicting the effects of climate on plants and animals. CSIRO.

UNESCO, 1979. Map of the world distribution of arid regions. Map at scale 1:25,000,000 with explanatory note. United Nations Educational, Scientific and Cultural Organization, Paris, 54 pp. ISBN 92-3-101484-6

ANNEX 1. CHARACTERIZATION OF SHEEP AND GOAT BREEDS OF MOROCCO INCLUDED IN THE STUDY

Special adaptations, production systems, body characteristics, products and direct link to DAD-IS breed entry

Table 17. Characterization of sheep and goat breeds of Morocco

Most common breed name	Special adaptation*	Production System	Tail type (in sheep)	Wool/hair	Body size**	Main products	DAD-IS link
Goats							
Argane goat	hot/humid, solar radiation, not adapted to walking	silvopastoral, Argane forest		hair		meat, skins, milk	
Atlas Mountain (Noire de l'Atlas)	solar radiation, stony substrates	pastoral		hair		meat, skins, milk	
Barcha	solar radiation	pastoral		hair		meat, skins, milk	
Draa	**saline water**, not adapted to walking	Oasis		hair		milk, meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_978
Sheep							
Béni Ahsen (BniHsen, BéniHsen)	**humid climates**	Agroforestry	thin	finest wool, heavy fleece	1	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_984
BéniGuil	solar radiation	pastoral	thin & short	medium fine	3	meat, wool, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_1004
Boujaâd	solar radiation, stony substrates, **saline water**	agropastoral	thin	medium fine	2	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_1016
D'man (Demane, Dman)	**saline wate**r, not adapted to walking	Oasis	thin & long	light, coarse	4	meat, manure, high fertility, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_1005
Sardi	solar radiation, stony substrates, **saline water**	agropastoral	thin		1	excellent meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_989

Timahdit (Timahdite)	snowfall	pastoral	thin	coarse	2	meat, milk, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_993

*The fields for breeds with relatively unique adaptive traits or interesting combinations of adaptive traits are shaded in grey; ** Ranking of body size within species ytghzx

Table 18. Characterization of sheep and goat breeds of Egypt

Most common breed name	Special adaptation*	Production System	Tail type (in sheep)	Wool/hair	Body size**	Main products	DAD-IS link
Goats							
Abouramad-Halaieb-Shalateen (AHS)	sandy substrate	pastoral		long hair, black	3	meat, skin, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500066
Baladi (Sharkawi)	hot/humid, solar radiation	mixed systems		long straight hair	1	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500066
Barki	solar radiation, sandy substrate	extensive transhumant grazing*		long hair, black	2	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500066
Black Sinai	solar radiation, sandy substrate	agropastoral, extensive grazing		no info	3	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500066
Saidi/Saeidi	solar radiation	mixed systems				meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500066
Wahati	solar radiation, sandy substrate, **saline water**	oasis		long glossy hair	2	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500066
Zaraibi (Nubian)	hot/humid, not adapted to walking	mixed systems and agroforesty		short hair	1	milk, meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500066
Sheep							
Barki	solar radiation, sandy substrate	extensive transhumant grazing***	fat-tail	open fleece less coarse than Rahmani and Ossimi	3	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500118
Abudeleik, Kanzi and Maenit	solar radiation, sandy substrate	transhumance following rain; mixed herds	fat-tail, long	short hair	6	meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500118
Fallahi/Fellahi (Baladi)	sandy substrate	mixed systems/scavenger	fat-tail	open coarse medium length luster	6	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500118

Most common breed name	Special adaptation*	Production System	Tail type (in sheep)	Wool/hair	Body size**	Main products	DAD-IS link
Farafra	sandy substrate	oasis, agropastoral	fat-tail	no info	8	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500118
Ossimi		mixed systems	fat-tail	open coarse often glossy	2	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500119
Rahmani	hot/humid, not adapted to walking	mixed systems	fat-tail	long, straight wool	1	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500119
Saidi/Sanabawi	solar radiation	mixed systems	fat-tail, long, cylindrical	open, long, coarse, wool on belly, legs, forehead	5	meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500119
Sohagi	solar radiation	mixed systems	fat-tail	coarse wool	3	meat, wool	

*The fields for breeds with relatively unique adaptive traits or interesting combinations of adaptive traits are shaded in grey; ** Ranking of body size within species

Table 19. Characterization of sheep and goat breeds of Iran

Most common breed name	Special adaptation*	Production System	% of SR popula-tion**	Tail (in sheep)	Wool/hair	Body size***	Main products	DAD_IS link
Goats								
Adani		semi-nomadic, mixed systems/village rearing	1.5				meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5000683
Birjandi (Balouchi)		semi-nomadic, mixed systems/village rearing	3.3				meat, milk	
Markhoz, Marghoz	cold/humid, snowfall	village rearing	1.7		Mohair	med	meat, milk, Mohair	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5000683
Najdi	not walking	semi-nomadic,mixed systems/village rearing	0.2		hair	med	milk, meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5000683
Nodoshan (Yazdi)			1.9				meat, milk	
Raeini		nomadic, semi-nomadic	7.4		Cashmere, hair	med	meat, milk, Cashmere, meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5000683
Tali	hot/humid	mixed systems/village rearing in small family flocks	0.5		hair	med	milk, meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5000683
Sheep								
Afshari	solar radiation, snowfall	semi-nomadic, mixed systems/village rearing	2.8	fat tail		8	meat, milk, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001348
Arabi	solar radiation	nomadic/semi-nomadic, mixed systems/village rearing	2.8	small fat tail			meat, milk, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001225

Most common breed name	Special adaptation*	Production System	% of SR popula-tion**	Tail (in sheep)	Wool/hair	Body size***	Main products	DAD_IS link
Bahmei	solar radiation, snowfall, stony substrates	nomadic and semi-nomadic	0.4	fat tail			meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001225
Balouchi		nomadic and semi-nomadic	12.1	round fat tail		3	meat, milk, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Dalagh	**humid climates**	semi-nomadic, mixed systems/village rearing	0.2	semi-fat tail	coarse carpet	3	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Farahani	hot/humid	semi-nomadic, mixed systems/village rearing	1.1				meat, milk	
Fashandi		semi-nomadic, mixed systems/village rearing	1.3				meat, milk	
Ghashghaei		nomadic and semi-nomadic	2.8	small fat tail	coarse	3	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227
Ghezel (Kizil)		semi-nomadic, mixed systems/village rearing	4.6	fat tail	coarse carpet wool	5	meat, milk, carpet wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227
Gray Shiraz	solar radiation	nomadic/semi-nomadic, and mixed systems/village rearing	0.9	small fat tail	coarse	5	milk, meat, pelt	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Kalkouhi, Kalkohi	not adapted to walking	semi-nomadic, mixed systems/village rearing	0.4	medium fat tail	high quality wool	5	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Karakul (black)		semi-nomadic, mixed crop-livestock and village rearing	0.6	long fat tail	coarse	5	meat, milk, pelt	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Kermani		semi-nomadic, mixed crop-livestock and village rearing	3.3				meal. Milk	

Most common breed name	Special adaptation*	Production System	% of SR popula-tion**	Tail (in sheep)	Wool/hair	Body size***	Main products	DAD_IS link
Kurdi Khorasan	snowfall	semi-nomadic, mixed crop-livestock and village rearing	2.0	medium fat tail	coarse	4	meat type, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Kurdi Kordestan	snowfall	semi-nomadic, mixed systems/village rearing	2.0	medium fat tail	coarse for quality carpets	6	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Lory Bakhtiary (Lori-Bakhtiyari)		nomadic, semi-nomadic, and mixed systems/village rearing	8.3	large fat tail	coarse	6	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001225
Lory (Lori)		nomadic/semi-nomadic, and mixed systems/village rearing	8.3	large fat tail	coarse	6	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001349
Makui		nomadic/semi-nomadic, mixed systems/village rearing	2.8	short fat tail	coarse carpet	4	meat, milk, (wool)	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Mehrabani		semi-nomadic, mixed mixed systems/village rearing	1.9	medium fat tail	coarse	2	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001226
Moghani	snowfall	nomadic/semi-nomadic, mixed systems/village rearing	6.5	fat tail	coarse	4	meat-type, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227
Naeini			0.6				meat, milk	
Sangsari	solar radiation	nomadic/semi-nomadic, and village rearing	0.2	medium fat tail	coarse	3	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227
Sanjabi	solar radiation	semi-nomadic, mixed crop-livestock and village rearing	1.9			5	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227

Most common breed name	Special adaptation*	Production System	% of SR popula-tion**	Tail (in sheep)	Wool/hair	Body size***	Main products	DAD_IS link
Shal (Chal)	snowfall	mixed crop-livestock and village rering	0.9	fat tail	coarse	7	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227
Taleshi	**humid climates**	semi-nomadic, mixed systems/village rearing	0.8	semi-fat tail	coarse	1	meat-type, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227
Zandi		semi-nomadic, mixed systems/ village rearing	0.9	semi fat tail	coarse	3	meat, milk, pelt	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001349
Zel	**humid climates**	semi-nomadic, mixed mixed systems/village rearing	3.7	thin tail	coarse, low quality	1	meat-type, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_5001227

*The fields for breeds with relatively unique adaptive traits or interesting combinations of adaptive traits are shaded in grey; **% of small ruminant (SR) population; ***For sheep body size is ranked within species

Table 20. Characterization of sheep and goat breeds of Turkey

Most common breed name	Special adaptation*	Production System	% in population**	Tail (in sheep)	Wool/hair	Body size	Main products	DAD_IS link
Goats								
Angora (Tiftik)	solar radiation, snowfall	mixed systems, base areas, foothills	1-2		Mohair	small	meat, mohair	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500073
Gürçü (from Georgian immigrants)	cold/humid	mixed systems	< 1		hair	no info	milk, meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500073
Kil (Hair), Kara Keçi (black goat)	cold/humid, solar radiation, snowfall, stony substrate	agropastoral, mountain agriculture	> 90		rough hair	medium	milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500073
Kilis (Damascus (20-85%) x Kil cross)	not adapted to walking	agroforestry, base areas, foothills	6-7		hair	medium	milk, meat, hair	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500074
Norduz	solar radiation, snowfall, stony substrates	sedentary mixed systems, higher rainfall	< 1		hair	medium	milk, meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500073
Maltiz (Maltese)	hot/humid, solar radiation, sandy substrate, not adapted to walking	Coastal, higher rainfall, orchards, & vegetables	< 1		hair		milk, meat	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500073
Sheep								
Akkaraman (White Karaman) - subtype common	solar radiation, snowfall	sedentary mixed systems	48.5	fat tail (5-6 kg)	best carpet quality	small	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Akkaraman - subtype Kangal	solar radiation, snowfall	sedentary mixed systems		fat tail	coarse	largest	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500136
Akkaraman- subtype Karakaş	solar radiation, snowfall	transhumant		fat tail	coarse	medium	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500136

Most common breed name	Special adaptation*	Production System	% in popula-tion**	Tail (in sheep)	Wool/hair	Body size	Main products	DAD_IS link
Akkaraman - subtype Norduz	solar radiation, snowfall	mixed systems		fat tail	coarse	medium	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
AmasyaHerik	solar radiation, snowfall	mixed systems	< 1	short fat tail	mixed coarse	medium	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Awassi (Ivesi)	solar radiation, sandy and stony substrate	mixed systems	6-7	fat tail (3kg)	coarse	medium	milk, meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Daglic (Dağliç)	cold/humid, snowfall	mixed systems in Western Mountain Area	7	fat-tail with thin end	known for carpet wool	smallest	meat, milk, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
GüneyKaraman (Black Karaman)	cold/humid, solar radiation, snowfall, stony substrates	mixed systems, cold mountain areas	< 1	fat rump/tail	coarse	small	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Hemşin (Morkaraman x Karayaka)	hot/humid	mixed systems, Black sea mountains, high rainfall, Karayaka area	< 1	thick thin tail	coarse	small	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Herik (Sirrt)	not adapted to walking	mixed systems	< 1	long fat tail	coarse (Carpet)	small	meat, milk	
Imroz (Gökçeada)	humid climates	mixed systems	< 1	thin-tail	long fleece (23 cm)	medium	meat, milk, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Karayaka (black)	humid climates	mixed systems, Black Sea coast, high rainfall	3	long thin tail	long wool, no crimp	medium to small	delicious meat, milk, wool for matraz	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Karacabey Merino (Crossbred with Akkaraman)	solar radiation, snowfall	mixed systems	1-2	thin tail	dense, uniform wool	medium	meat, (milk), wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500136
Anatolian (Konya) Merino (Crossbred with Morkaraman)	snowfall, solar radiation,	transhumant	1.2	thin tail	dense, uniform wool	medium	meat, (milk)	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500136

Most common breed name	Special adaptation*	Production System	% in popula-tion**	Tail (in sheep)	Wool/hair	Body size	Main products	DAD_IS link
Kivircik	cold/humid, snowfall	sedentary mixed systems, hilly areas, good rainfall	5	thin tail	coarse	medium	milk, delicious meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Morkaraman (Red Karaman)	cold/humid, solar radiation, snowfall, stony substrates	mixed systems	19	fat tail (5-6 kg)	coarse	medium	meat, milk, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Sakız (Chios)	not adapted to walking, hot/humid, solar radiation	mixed systems in coastal areas	< 1	semi fat tail	coarse	tall	meat, milk, very fertile, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Tuy (Tujin)	solar radiation, snowfall, stony substrates	mixed systems	< 1	fat tail	coarse, low quality	small	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Tahirova (Kivircik crossbred)	solar radiation, snowfall	sedentary mixed systems		thin tail			milk, meat, wool	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500130
Ödemiş	n.a.***		extinct (begin 80ties)	fat tail (18 kg)	coarse, short	medium	meat, milk	http://dad.fao.org/cgi-bin/EfabisWeb.cgi?sid=-1,reportsreport8a_500136

*The fields for breeds with relatively unique adaptive traits or interesting combinations of adaptive traits are shaded in grey; **% of goat or sheep population; ***n.a.=not available

ANNEX 2. ENVIRONMENTAL CHARACTERIZATION OF BREED DISTRIBUTION AREAS[10,11]

EGYPT

Annual precipitation

Table 21. Areas (%) in different precipitation classes in the sheep breed distribution areas of Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indige-nous (Baladi)	Ossimi	Rahmani	Saidi / Shana-bawi	Sohagi
Annual precipitation class (mm)	(%)							
0-100	89.9	0.6	100.0	78.9	95.9	40.9	100.0	100.0
100-200	9.0	99.4	0.0	20.3	4.1	57.7	0.0	0.0
200-300	1.1	0.0	0.0	0.7	0.0	1.4	0.0	0.0
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 22.Areas (%) in different precipitation classes in the goat breed distribution areas of Egypt

Goat breeds	Aburamad, Halaieb, Shalatin	Barki	Black Sinai	Indige-nous (Baladi)	Saidi	Wahati	Zaraibi
Annual precipitation class (mm)	(%)						
0-100	89.9	0.5	60.3	93.4	100.0	100.0	92.0
100-200	9.0	99.5	38.4	6.4	0.0	0.0	8.0
200-300	1.1	0.0	1.3	0.1	0.0	0.0	0.0
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

[10] In all tables all values exceeding 20% are shown on a pink background to enhance patterns and differences.

[11] In all tables the values are the percentages each class occupies of a breed area. Ex.g. in the first table 95.9% of the distribution area of the Ossimi sheep has an annual precipitation of 0-100 mm, the remaining 4.1% an annual precipitation range of 100-200 mm.

Agro-climatic Zones

Table 23. Areas (%) in different agro-climatic zones in the sheep breed distribution areas of Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indigenous (Baladi)	Ossimi	Rahmani	Saidi / Shanabawi	Sohagi
Agro-climatic zone	(%)							
3	24.5	0.0	35.3	4.7	0.0	0.0	26.4	60.1
4	45.3	0.0	64.1	47.9	70.3	0.0	59.3	18.4
16	1.7	0.0	0.1	0.2	0.0	0.0	2.7	6.1
17	23.7	100.0	0.5	40.4	29.7	100.0	11.7	15.4
20	4.8	0.0	0.0	6.8	0.0	0.0	0.0	0.0
Total breed area (sq.km)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 24.Areas (%) in different zones in the goat breed distribution areas of Egypt

Goat breeds	Aburamad, Halaieb, Shalatin	Barki	Black Sinai	Indigenous (Baladi)	Saidi	Wahati	Zaraibi
Agro-climatic zone	(%)						
3	24.5	0.0	3.3	19.0	26.4	35.1	50.4
4	45.4	0.0	20.2	54.1	59.3	64.4	18.7
16	1.7	0.0	0.0	2.0	2.7	0.1	0.0
17	23.6	100.0	60.4	25.0	11.5	0.4	30.9
20	4.7	0.0	16.1	0.0	0.0	0.0	0.0
Total breed area (sq.km)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

Landforms

Table 25.Areas (%) in different landform classes in the sheep breed distribution areas of Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indige-nous (Baladi)	Ossimi	Rahmani	Saidi / Shana-bawi	Sohagi
Landform class	(%)							
Plains	46.7	98.6	87.8	72.0	98.6	97.3	86.0	82.0
Hills	48.9	1.4	12.2	25.1	1.4	2.7	13.9	17.8
Mountains	4.4	0.0	0.0	2.9	0.0	0.0	0.1	0.2
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 26.Areas (%) in different landform classes in the goat breed distribution areas of Egypt

Goat breeds	Aburamad, Halaieb, Shalatin	Barki	Black Sinai	Indige-nous (Baladi)	Saidi	Wahati	Zaraibi
Landform class	(%)						
Plains	46.7	98.5	55.2	89.2	86.0	88.2	95.4
Hills	48.7	1.5	38.7	10.7	13.9	11.8	4.6
Mountains	4.6	0.0	6.1	0.1	0.1	0.0	0.0
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

Land use/land cover

Table 27. Areas (%) in different land use/land cover classes in the sheep breed distribution areas of Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indige-nous (Baladi)	Ossimi	Rahmani	Saidi / Shana-bawi	Sohagi
Land use/ land cover class	(%)							
Irrigated	0.1	17.6	9.5	20.3	71.9	96.0	19.2	14.9
Rangelands	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
Barren	99.8	80.5	90.5	78.2	25.6	1.6	78.4	82.6
Other	0.1	1.1	0.0	1.5	2.5	2.4	2.4	2.5
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 28. Areas (%) in different land use/land cover classes in the goat breed distribution areas of Egypt

Goat breeds	Aburamad, Halaieb, Shalatin	Barki	Black Sinai	Indige-nous (Baladi)	Saidi	Wahati	Zaraibi
Land use/ land cover class	(%)						
Irrigated	0.1	17.5	0.1	33.6	19.3	9.4	39.5
Rangelands	0.0	1.1	0.0	0.0	0.0	0.0	0.0
Barren	99.8	80.4	99.7	63.6	78.2	90.6	40.5
Other	0.2	1.1	0.2	2.8	2.4	0.0	20.1
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

Soil Management Domains

Table 29. Areas (%) in different soil management domains in the sheep breed distribution areas of Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indige-nous (Baladi)	Ossimi	Rahmani	Saidi / Shana-bawi	Sohagi
Soil Management Domain	(%)							
00	0.0	20.3	0.0	20.5	74.3	100.0	18.7	13.1
20	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.0
28	6.4	0.0	0.0	4.2	16.2	0.0	9.3	13.5
40	0.0	0.0	33.7	0.8	0.0	0.0	0.0	0.0
50	64.9	0.0	0.0	17.9	0.0	0.0	5.2	11.8
57	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	22.9	25.2	12.4	3.2	0.0	0.0	4.2	9.7
75	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
78	4.3	39.9	27.7	33.6	3.5	0.0	59.1	47.0
80	1.5	0.8	0.0	6.7	6.1	0.0	2.2	4.4
81	0.0	0.0	17.2	0.0	0.0	0.0	0.0	0.0
83	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
DS0	0.0	0.0	9.0	7.8	0.0	0.0	0.5	0.0
DS8	0.0	13.8	0.0	0.0	0.0	0.0	0.0	0.0
WR	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4
Total breed area (sq.km)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 30. Areas (%) in different soil management domains in the goat breed distribution areas of Egypt

Goat breeds	Aburamad, Halaieb, Shalatin	Barki	Black Sinai	Indige-nous (Baladi)	Saidi	Wahati	Zaraibi
Soil Management Domain	(%)						
00	0.0	20.1	0.0	33.4	18.8	0.0	40.7
20	0.0	0.0	0.0	0.4	0.5	0.0	0.0
28	6.4	0.0	0.0	9.0	9.4	0.0	4.8
40	0.0	0.0	0.0	1.1	0.0	33.4	3.3
50	64.9	0.0	23.0	3.7	5.2	0.0	6.7
57	0.0	0.0	12.6	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	23.0	25.2	0.0	3.1	4.3	12.4	24.8
75	0.0	0.0	0.4	0.0	0.0	0.0	0.0
78	4.3	40.5	33.8	43.4	58.9	28.0	0.8
80	1.4	0.8	11.0	4.8	2.2	0.0	0.0
81	0.0	0.0	0.0	0.0	0.0	17.3	0.0
83	0.0	0.0	0.0	0.1	0.0	0.0	0.5
DS0	0.0	0.0	19.1	0.9	0.5	9.0	0.0
DS8	0.0	13.4	0.0	0.0	0.0	0.0	0.0
WR	0.0	0.0	0.0	0.1	0.2	0.0	18.3
Total breed area (sq.km)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

Agro-ecological zones

Table 31. Areas (%) in different agro-ecological zones in the sheep breed distribution areas of Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indige-nous (Baladi)	Ossimi	Rahmani	Saidi / Shana-bawi	Sohagi
Agro-ecological zone	(%)							
110	0.0	0.0	0.0	13.4	64.0	19.7	18.7	13.1
131	42.8	0.0	97.6	42.0	24.1	0.0	73.2	75.1
132	55.4	0.0	2.4	22.1	0.3	0.0	7.9	11.8
133	1.8	0.0	0.0	2.1	0.0	0.0	0.0	0.0
210	0.0	20.3	0.0	7.1	10.3	80.3	0.0	0.0
231	0.0	79.6	0.0	11.4	1.3	0.0	0.2	0.0
232	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
332	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (sq.km)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 32. Areas (%) in different agro-ecological zones in the goat breed distribution areas of Egypt

Goat breeds	Aburamad, Halaieb, Shalatin	Barki	Black Sinai	Indige-nous (Baladi)	Saidi	Wahati	Zaraibi
Agro-ecological zone	(%)						
110	0.0	0.0	0.0	23.3	18.8	0.0	24.5
131	42.9	0.0	27.8	59.8	73.1	97.6	55.6
132	55.3	0.0	34.0	5.7	7.9	2.4	1.2
133	1.8	0.0	4.8	0.0	0.0	0.0	0.0
210	0.0	20.1	0.0	10.1	0.0	0.0	16.2
231	0.0	79.9	28.0	1.2	0.2	0.0	2.5
232	0.0	0.0	5.2	0.0	0.0	0.0	0.0
332	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Total breed area (sq.km)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

Annual precipitation

Table 33.Areas (%) in different precipitation classes in the sheep breed distribution areas of Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Farahani	Fashan-di	Ghash-ghaye	Ghezel
Annual precipitation class (mm)	(%)								
<100	0.0	0.0	0.0	33.0	0.1	0.0	0.0	0.0	0.0
100-200	0.0	50.9	0.0	48.9	0.0	0.0	0.0	3.4	0.0
200-300	0.0	33.0	40.1	12.3	50.0	35.4	3.1	44.4	0.0
300-400	48.5	9.3	26.2	4.8	29.6	56.8	21.4	35.8	25.6
400-500	45.9	3.8	21.1	0.8	15.3	7.3	27.7	12.7	40.5
500-600	4.3	1.3	9.8	0.2	4.5	0.4	17.9	3.1	18.1
600-700	0.9	0.1	2.3	0.1	0.3	0.0	13.3	0.6	9.8
700-800	0.3	0.0	0.4	0.0	0.1	0.0	9.4	0.1	2.9
800-900	0.1	0.0	0.2	0.0	0.0	0.0	4.0	0.0	1.6
900-1000	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	1.1
1000-1100	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.1
1100-1200	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 34. Areas (%) in different precipitation classes in the sheep breed distribution areas of Iran (2)

Sheep breeds	Gray shiraz	Kalkouhi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Annual precipitation class (mm)	(%)								
<100	0.0	0.0	0.0	30.1	0.1	0.0	0.0	0.9	0.0
100-200	24.5	30.4	8.6	48.8	0.0	0.0	0.0	16.7	0.0
200-300	59.3	39.6	86.2	19.4	22.9	2.5	1.1	25.5	6.0
300-400	14.1	21.2	5.2	1.6	41.1	14.8	34.4	21.0	31.5
400-500	2.1	3.3	0.0	0.2	28.1	43.6	56.6	21.0	23.7
500-600	0.0	2.2	0.0	0.0	6.8	32.7	7.0	10.5	18.8
600-700	0.0	1.8	0.0	0.0	1.0	6.0	0.7	3.3	10.6
700-800	0.0	1.0	0.0	0.0	0.0	0.1	0.1	0.9	5.2
800-900	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.2	2.5
900-1000	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1
1000-1100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
1100-1200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 35. Areas (%) in different precipitation classes in the sheep breed distribution areas of Iran (3)

Sheep breeds	Mehra-bani	Moghani	Naeini	Sangsari	Sanjabi	Shal	Taleshi	Zandi	Zel
Annual precipitation class (mm)	(%)								
<100	0.0	0.0	34.7	0.0	0.0	0.0	0.0	0.0	0.0
100-200	0.0	0.0	39.3	64.3	0.0	0.3	0.0	29.0	0.0
200-300	11.0	0.6	15.0	23.3	4.1	29.7	0.0	38.7	19.9
300-400	62.6	29.3	5.7	5.2	25.2	43.0	0.0	14.3	14.0
400-500	23.8	31.0	3.8	3.4	47.8	14.5	2.2	6.9	12.2
500-600	1.2	22.8	1.2	1.9	21.0	5.3	29.5	4.3	14.8
600-700	0.5	10.4	0.2	1.1	1.7	3.4	15.1	3.2	15.0
700-800	0.3	3.5	0.0	0.6	0.1	2.0	6.2	2.1	11.1
800-900	0.4	1.2	0.0	0.2	0.0	1.1	3.9	0.8	6.3
900-1000	0.2	0.5	0.0	0.1	0.0	0.6	3.7	0.4	2.5
1000-1100	0.0	0.3	0.0	0.0	0.0	0.1	3.9	0.1	1.2
1100-1200	0.0	0.1	0.0	0.0	0.0	0.0	3.9	0.0	1.4
1200-1300	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.9
1300-1500	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.1
1500-2000	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 36. Areas (%) in different precipitation classes in the goat breed distribution areas of Iran

Goat breeds	Adani	Birjandi (Balou-chi)	Marghoz	Nado-shan	Najdi	Raeini	Tali
Annual precipitation class (mm)	(%)						
<100	0.0	38.6	0.0	55.3	0.0	32.4	7.0
100-200	63.5	52.9	0.0	41.2	78.2	46.6	78.0
200-300	32.4	8.2	0.0	3.0	19.2	18.9	13.5
300-400	0.3	0.3	0.2	0.3	0.3	1.6	0.1
400-500	0.0	0.0	35.7	0.1	0.0	0.2	0.0
500-600	0.0	0.0	50.9	0.0	0.0	0.0	0.0
600-700	0.0	0.0	12.7	0.0	0.0	0.0	0.0
700-800	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Agro-climatic zones

Table 37. Areas (%) in different agro-climatic zones in the sheep breed distribution areas of Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Farahani	Fashandi	Ghash-ghaye	Ghezel
Agro-climatic zone					(%)				
3	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
16	0.0	74.5	14.4	14.7	0.0	0.0	0.0	6.2	0.0
17	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
19	0.0	3.3	15.1	34.4	0.0	0.0	0.0	10.9	0.0
20	0.0	0.4	0.5	38.0	32.0	10.8	0.0	10.8	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.6	4.8	11.6	0.0	0.7	0.0
25	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
29	0.0	1.9	0.3	0.0	0.0	0.0	0.0	0.1	0.0
32	0.0	12.3	10.3	0.0	0.0	0.0	0.0	4.8	0.0
33	0.0	5.8	35.0	3.9	47.1	0.5	8.2	43.2	0.6
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	91.4	0.7	19.0	3.8	6.0	76.3	52.6	20.3	69.5
38	7.5	0.0	1.9	0.3	9.4	0.8	10.9	2.1	14.3
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.1	0.0	0.3	0.0	0.0	0.0	4.0	0.1	0.7
50	0.6	0.1	1.7	0.0	0.0	0.0	2.9	0.4	7.9
51	0.3	0.0	1.6	0.0	0.2	0.0	18.0	0.4	4.7
52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.3
63	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
64	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.6
65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 38. Areas (%) in different agro-climatic zones in the sheep breed distribution areas of Iran (2)

Sheep breeds	Gray shiraz	Kalkouhi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Agro-climatic zone					(%)				
3	0.0	0.0	0.0	16.8	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
16	20.6	0.0	0.0	19.6	0.0	0.1	0.0	13.8	0.0
17	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
19	13.0	31.6	15.0	10.9	0.1	1.0	0.0	1.3	0.0
20	36.3	19.1	68.7	46.9	16.7	0.0	0.0	17.6	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	11.4	0.0	1.2	0.7	0.0	0.0	1.7	2.0
25	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.5	0.0
32	0.2	0.0	0.0	0.0	0.0	9.0	11.3	9.3	0.0
33	27.6	2.6	13.9	0.6	8.9	18.7	50.5	13.7	0.8
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	2.2	30.5	2.1	0.5	62.3	59.8	36.1	33.1	74.0
38	0.2	2.0	0.0	1.9	10.7	0.6	1.2	2.4	6.2
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.1	0.0
50	0.0	0.3	0.0	0.0	0.0	8.6	0.3	1.9	1.5
51	0.0	2.3	0.0	0.0	0.4	0.5	0.5	2.7	13.5
52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.6
65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 39. Areas (%) in different agro-climatic zones in the sheep breed distribution areas of Iran (3)

Sheep breeds	Mehra-bani	Moghani	Naeini	Sangsari	Sanjabi	Shal	Taleshi	Zandi	Zel
Agro-climatic zone					(%)				
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	1.4	0.0	44.1	43.6	1.5	2.1	0.0	35.5	0.0
20	2.4	0.0	32.6	37.4	0.0	10.7	0.0	19.6	16.3
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	4.4	0.4	10.1	5.3	0.0	14.0	0.0	8.0	1.2
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0
33	4.4	13.7	0.2	1.3	46.5	2.9	0.3	3.0	26.6
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	84.8	49.0	11.8	8.4	32.0	59.4	10.5	24.6	10.7
38	1.1	24.2	1.0	2.4	0.9	4.0	23.6	3.1	6.8
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.5	0.5	0.0	0.0	0.8	2.0	3.3	0.0	13.7
50	0.2	1.2	0.0	0.3	2.6	0.7	7.7	1.0	3.8
51	0.1	9.8	0.1	1.3	0.4	2.8	8.5	4.6	10.8
52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	0.6	0.0	0.0	0.0	0.0	1.2	5.2	0.0	5.4
63	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
64	0.0	0.9	0.0	0.1	0.0	0.2	0.8	0.5	1.2
65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
72	0.0	0.0	0.0	0.0	0.0	0.0	37.4	0.0	3.1
76	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
78	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.1
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 40. Areas (%) in different agro-climatic zones in the goat breed distribution areas of Iran

Goat breeds	Adani	Birjandi (Balou-chi)	Marghoz	Nado-shan	Najdi	Raeini	Tali
Agro-climatic zone	(%)						
3	0.0	3.3	0.0	0.0	0.0	18.7	0.0
6	0.0	2.0	0.0	0.0	0.0	0.7	0.0
16	89.2	3.9	0.0	0.0	97.2	35.7	83.8
17	0.0	0.0	0.0	0.0	0.0	0.7	1.7
19	5.5	45.5	0.0	47.7	0.5	7.6	4.3
20	1.7	44.1	0.0	48.9	0.0	31.8	9.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.5	0.0	2.6	0.0	1.0	0.0
25	0.0	0.0	0.0	0.2	0.0	0.6	0.0
29	0.1	0.0	0.0	0.0	0.2	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.6	0.0	0.0	0.0	0.7	0.0	0.0
33	1.2	0.1	1.4	0.0	0.2	0.6	0.3
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	0.0	0.5	76.7	0.2	0.0	0.5	0.0
38	0.0	0.0	0.8	0.3	0.0	2.0	0.0
46	0.0	0.0	1.8	0.0	0.0	0.0	0.0
50	0.0	0.0	17.9	0.0	0.0	0.0	0.0
51	0.0	0.0	1.1	0.0	0.0	0.0	0.0
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Landforms

Table 41. Areas (%) in different landform classes in the sheep breed distribution areas of Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Farahani	Fashan-di	Ghash-ghaye	Ghezel
Landform class	(%)								
Plain	17.5	57.2	3.9	51.2	55.7	29.5	15.8	17.9	14.9
Hills	74.3	31.4	45.7	44.7	13.4	59.5	23.1	51.1	68.8
Mountains	8.2	10.9	50.4	4.0	30.7	11.0	61.1	31.1	16.1
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 42. Areas (%) in different landform classes in the sheep breed distribution areas of Iran (2)

Sheep breeds	Gray shiraz	Kalkouhi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Landform class	(%)								
Plain	26.2	46.1	38.4	44.0	17.1	13.1	10.1	26.3	20.7
Hills	51.0	41.2	58.6	46.9	68.2	65.6	61.0	41.9	56.1
Mountains	22.8	12.7	2.6	9.1	14.5	21.0	29.0	31.8	23.0
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 43. Areas (%) in different landform classes in the sheep breed distribution areas of Iran (3)

Sheep breeds	Mehra-bani	Moghani	Naeini	Sangsari	Sanjabi	Shal	Taleshi	Zandi	Zel
Landform class	(%)								
Plain	32.2	16.3	50.4	59.7	13.9	28.9	24.8	42.2	27.0
Hills	59.5	64.1	43.7	32.2	60.5	49.9	32.4	40.2	25.2
Mountains	8.3	19.5	5.9	8.0	25.5	21.3	42.3	17.6	47.7
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 44. Areas (%) in different landform classes in the goat breed distribution areas of Iran

Goat breeds	Adani	Birjandi Balouchi	Marghoz	Nado-shan	Najdi	Raeini	Tali
Landform class	(%)						
Plain	0.0	38.6	0.0	55.3	0.0	32.4	7.0
Hills	63.5	52.9	0.0	41.2	78.2	46.6	78.0
Mountains	32.4	8.2	0.0	3.0	19.2	18.9	13.5
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Land use/land cover

Table 45. Areas (%) in different land use/land cover classes in the sheep breed distribution areas of Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Farahani	Fashan-di	Ghash-ghaye	Ghezel
Land use/land cover class	(%)								
Barren	12.7	55.6	15.8	95.3	10.0	73.5	25.8	45.0	7.5
Forests	0.1	0.0	0.1	0.1	32.8	0.2	1.6	1.8	2.9
Irrigated crops	2.5	5.1	2.7	2.0	28.7	2.8	13.5	6.0	5.4
Rainfed crops	9.2	2.3	2.1	0.1	7.3	1.1	4.0	3.1	24.7
Rangelands	75.4	34.8	79.2	2.4	20.3	21.5	54.8	43.9	58.2
Others	0.0	1.2	0.1	0.1	0.9	0.9	0.2	0.3	1.0
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 46. Areas (%) in different land use/land cover classes in the sheep breed distribution areas of Iran (2)

Sheep breeds	Gray shiraz	Kalkouhi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Land use/land cover class	(%)								
Barren	64.4	74.4	49.2	95.6	30.5	6.8	21.6	45.1	10.8
Forests	1.7	1.2	0.0	0.1	0.1	1.7	2.7	1.1	5.1
Irrigated crops	4.4	4.8	8.8	1.1	10.0	0.4	2.1	6.3	11.3
Rainfed crops	3.8	1.3	2.0	0.3	3.0	23.0	10.4	2.6	16.2
Rangelands	25.5	17.4	39.8	2.9	56.2	67.5	63.2	44.6	54.6
Others	0.2	0.9	0.0	0.0	0.1	0.2	0.1	0.3	1.9
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 47. Areas (%) in different land use/land cover classes in the sheep breed distribution areas of Iran (3)

Sheep breeds	Mehra-bani	Moghani	Naeini	Sangsari	Sanjabi	Shal	Taleshi	Zandi	Zel
Land use/land cover class					(%)				
Barren	32.1	7.6	92.7	92.0	15.4	34.6	1.2	73.7	4.5
Forests	1.6	4.7	0.9	0.3	3.7	1.3	15.6	0.8	27.7
Irrigated crops	2.0	9.0	1.9	2.3	1.8	5.3	38.7	6.6	31.7
Rainfed crops	4.5	24.4	0.3	0.3	17.2	3.1	6.1	0.9	9.1
Rangelands	59.5	53.9	4.2	4.8	61.6	55.3	34.3	16.9	25.9
Others	0.3	0.3	0.1	0.4	0.1	0.4	2.9	1.1	0.8
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 48. Areas (%) in different land use/land cover classes in the goat breed distribution areas of Iran

Goat breeds	Adani	Birjandi (Balou-chi)	Marghoz	Nado-shan	Najdi	Raeini	Tali
Land use/land cover class				(%)			
Barren	0.0	38.6	0.0	55.3	0.0	32.4	7.0
Forests	63.5	52.9	0.0	41.2	78.2	46.6	78.0
Irrigated crops	32.4	8.2	0.0	3.0	19.2	18.9	13.5
Rainfed crops	0.3	0.3	0.2	0.3	0.3	1.6	0.1
Rangelands	0.0	0.0	35.7	0.1	0.0	0.2	0.0
Others	0.0	0.0	50.9	0.0	0.0	0.0	0.0
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Soil Management Domains

Table 49. Areas (%) in different soil management domains in the sheep breed distribution areas of Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Fara-hani	Fashan-di	Ghash-ghaye	Ghezel
Soil management domain (%)									
00	2.5	2.4	0.0	0.5	52.8	0.0	2.6	3.8	20.1
10	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
20	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	0.0	35.7	0.0	17.8	20.7	4.8	4.3	0.0	0.7
44	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0
60	41.2	0.6	2.6	2.5	0.0	44.9	11.3	13.6	19.9
63	2.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.4
64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0
68	3.4	0.2	0.0	0.0	0.0	0.0	0.0	1.6	7.1
70	0.0	0.6	0.0	6.5	6.2	0.0	0.0	3.6	0.0
78	0.0	8.3	1.3	13.0	0.0	0.0	0.0	1.3	0.0
80	6.6	5.5	0.0	1.1	0.0	0.0	0.0	10.3	5.5
83	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85	22.5	24.9	53.5	2.8	3.8	0.0	0.0	21.8	10.4
88	21.8	14.4	42.7	42.7	12.0	50.3	80.0	42.1	32.1
DS8	0.0	2.6	0.0	4.1	0.0	0.0	0.0	0.0	0.0
ST	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.1	2.1
WR	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.5
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 50. Areas (%) in different soil management domains in the sheep breed distribution areas of Iran (2)

Sheep breeds	Gray shiraz	Kalkou-hi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Soil management domain (%)									
00	2.3	0.0	2.6	0.0	2.5	13.5	2.1	2.5	10.0
15	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
40	3.5	23.5	0.0	20.9	0.0	0.0	0.0	4.1	0.0
50	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
56	0.0	0.0	21.4	0.0	9.4	0.0	0.0	0.0	0.0
60	9.4	17.8	18.9	0.0	16.0	21.3	19.6	7.9	3.6
63	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
68	1.0	0.0	0.0	0.0	0.2	2.8	0.0	0.0	19.5
70	4.7	11.3	32.6	16.8	9.0	0.4	0.0	8.8	0.0
78	11.0	0.0	0.0	7.0	0.0	0.0	0.0	3.9	0.0
80	30.8	0.0	0.0	7.0	2.9	2.9	0.0	0.0	0.0
85	0.1	0.1	0.0	2.5	8.5	7.2	0.3	20.4	12.9
88	32.8	41.7	24.7	39.4	50.2	51.1	77.9	50.7	51.2
DS8	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.5	0.0
ST	2.7	5.3	0.0	2.8	0.0	0.0	0.0	0.6	1.9
WR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 51. Areas (%) in different soil management domains in the sheep breed distribution areas of Iran (3)

Sheep breeds	Mehra-bani	Mogha-ni	Naeini	Sangsa-ri	Sanjabi	Shal	Taleshi	Zandi	Zel
Soil management domain (%)									
00	0.2	23.0	0.0	1.7	4.1	0.7	53.0	3.1	57.3
10	0.0	0.0	0.0	0.7	0.0	0.0	2.0	0.0	4.1
15	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
40	0.9	1.3	18.2	23.5	0.0	2.3	0.0	23.8	6.2
44	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
60	42.7	14.8	5.0	0.5	12.1	21.4	7.4	8.8	2.2
63	0.0	0.0	0.0	0.0	0.0	7.2	0.0	0.2	0.0
68	2.6	8.9	0.0	0.0	0.3	0.0	0.0	0.0	0.0
70	2.7	0.0	18.5	13.7	0.6	10.1	0.0	14.2	2.0
78	0.0	0.0	0.1	0.7	0.0	0.0	0.0	0.0	0.0
80	0.4	0.0	0.0	1.1	0.0	0.0	0.2	2.5	3.0
85	9.5	10.8	4.0	15.3	6.1	7.8	0.0	4.5	3.3
88	41.1	38.9	41.8	23.6	76.7	50.5	35.1	38.7	21.8
DS8	0.0	0.0	5.8	1.2	0.0	0.0	0.0	0.0	0.0
ST	0.0	2.0	6.5	15.5	0.0	0.0	0.0	4.3	0.0
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 52. Areas (%) in different soil management domains in the goat breed distribution areas of Iran

Goat breeds	Adani	Birjandi (Balou-chi)	Marghoz	Nado-shan	Najdi	Raeini	Tali
Soil management domain	(%)						
00	2.6	0.4	29.5	0.0	1.8	0.0	0.0
20	0.0	0.0	0.0	0.0	2.4	0.0	0.0
40	41.8	18.0	0.0	34.4	69.6	20.1	18.8
44	0.0	0.1	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	1.0	0.0	0.0	0.0	0.0
60	0.0	0.0	16.5	0.0	1.5	0.0	0.0
68	0.8	0.0	1.4	0.0	0.0	0.0	0.0
70	0.0	5.4	0.0	15.9	0.0	13.4	7.1
78	2.1	17.1	0.0	2.5	6.1	8.9	7.8
80	25.2	1.0	6.4	0.0	0.0	11.0	42.5
83	0.0	0.0	0.0	0.0	0.1	0.0	0.0
85	26.9	1.7	2.6	3.2	15.7	2.2	0.1
88	0.0	44.8	42.6	35.6	0.2	36.7	22.5
DS8	0.0	4.7	0.0	2.0	1.5	4.2	0.5
ST	0.0	6.0	0.0	6.4	0.0	3.3	0.3
WR	0.0	0.9	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Agro-ecological zones

Table 53. Areas (%) in different agro-ecological zones in the sheep breed distribution areas of Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Faraha-ni	Fashan-di	Ghash-ghaye	Ghezel
Agro-ecological zone	(%)								
110	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
131	0.0	0.0	0.0	11.8	0.0	0.0	0.0	0.0	0.0
132	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0
210	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
231	0.0	53.4	0.1	8.1	0.0	0.0	0.0	0.0	0.0
232	0.0	22.7	16.8	6.6	0.0	0.0	0.0	8.6	0.0
233	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
310	0.0	0.0	0.0	0.3	16.2	0.0	0.0	1.2	0.0
321	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.6	0.0
322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
331	8.9	0.0	0.0	34.0	30.7	29.3	18.1	8.6	7.0
332	37.1	12.2	16.2	34.3	6.2	68.9	10.9	45.4	17.5
333	0.0	2.4	23.9	0.7	30.6	0.0	0.0	13.8	0.0
510	0.0	0.0	0.0	0.0	13.7	0.0	0.0	0.0	0.1
521	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
522	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9
523	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
531	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
532	45.3	3.2	12.7	0.5	0.0	1.8	5.0	14.4	41.4
533	3.4	2.7	28.2	0.0	0.0	0.0	40.9	7.3	5.5
610	0.0	0.0	0.0	0.1	0.9	0.0	0.0	0.0	0.0
622	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6
623	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
631	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
632	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8
633	0.4	0.0	2.1	0.0	0.0	0.0	25.2	0.2	0.6
810	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
832	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
833	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1310	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1331	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 54. Areas (%) in different agro-ecological zones in the sheep breed distribution areas of Iran (2)

Sheep breeds	Gray shiraz	Kalkou-hi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Agro-ecological zone					(%)				
110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
131	0.0	0.0	0.0	20.5	0.0	0.0	0.0	0.0	0.0
132	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0
210	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0
231	2.2	0.0	0.0	6.3	0.0	0.1	0.0	5.1	0.0
232	20.8	0.0	0.0	10.6	0.0	0.0	0.0	10.6	0.0
233	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
310	0.9	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
321	0.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
322	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
331	13.0	52.2	29.3	17.4	14.8	1.4	0.3	14.3	10.4
332	52.1	40.2	66.7	37.2	61.4	6.6	21.4	17.6	30.8
333	6.6	0.0	1.4	3.9	1.0	0.0	1.3	11.8	1.4
510	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
521	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
522	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.0	1.0
523	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	1.0
531	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	2.2
532	3.8	0.0	0.0	0.0	20.3	60.0	54.8	18.7	37.9
533	0.0	4.7	0.0	0.0	0.0	12.1	20.1	19.8	1.5
610	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.6
622	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
623	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1
631	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
632	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1
633	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.4	1.3
810	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
832	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
833	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1310	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1331	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 55. Areas (%) in different agro-ecological zones in the sheep breed distribution areas of Iran (3)

Sheep breeds	Mehra-bani	Moghani	Naeini	Sangsari	Sanjabi	Shal	Taleshi	Zandi	Zel
Agro-ecological zone					(%)				
110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
131	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
132	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
210	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
231	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
232	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
233	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
310	0.0	2.4	0.0	0.4	0.0	0.0	0.0	0.9	5.4
321	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.2
322	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
331	23.0	6.1	46.9	62.1	3.2	31.6	0.0	44.3	12.6
332	46.1	20.4	43.6	30.9	15.4	42.0	0.0	37.5	7.5
333	0.0	0.5	0.7	1.9	0.0	0.0	0.0	3.4	10.7
510	0.0	0.1	0.0	0.0	0.0	0.0	5.1	0.0	22.9
521	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
522	0.0	11.9	0.0	0.0	1.2	0.0	0.0	0.0	0.0
523	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
531	5.6	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0
532	23.0	25.0	3.5	0.9	59.9	6.0	3.5	1.9	0.0
533	2.1	5.8	0.0	1.1	17.0	16.0	16.8	4.7	21.2
610	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.7
622	0.0	6.9	0.0	0.0	0.0	0.0	5.5	0.0	0.0
623	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
631	0.0	1.4	0.0	0.0	0.0	0.0	3.4	0.0	0.0
632	0.0	15.5	0.0	0.3	0.0	0.0	15.3	0.6	0.0
633	0.0	2.5	0.0	2.4	0.0	4.0	6.8	6.8	13.7
810	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
832	0.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
833	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	1.5
1010	0.0	0.0	0.0	0.0	0.0	0.0	21.6	0.0	0.0
1310	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
1331	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 56. Areas (%) in different agro-ecological zones in the goat breed distribution areas of Iran

Goat breeds	Adani	Birjandi (Balou-chi)	Marghoz	Nado-shan	Najdi	Raeini	Tali
Agro-ecological zone	(%)						
110	0.0	0.1	0.0	0.0	0.0	0.0	0.0
131	0.0	14.9	0.0	28.0	0.0	21.4	0.0
132	0.0	3.5	0.0	11.3	0.0	4.2	0.0
210	0.0	0.0	0.0	0.0	1.8	0.0	0.0
231	38.8	1.2	0.0	0.0	84.9	14.8	29.4
232	52.9	0.3	0.0	0.0	11.8	18.3	57.8
233	4.1	0.0	0.0	0.0	0.0	1.0	3.1
310	0.0	0.3	0.0	0.0	0.0	0.0	0.0
331	0.0	43.1	0.0	27.1	0.0	9.1	0.6
332	3.6	35.8	0.0	32.6	0.2	26.6	7.4
333	0.0	0.7	0.0	1.0	0.2	4.4	1.3
522	0.0	0.0	23.2	0.0	0.0	0.0	0.0
523	0.0	0.0	6.3	0.0	0.0	0.0	0.0
531	0.0	0.0	2.9	0.0	0.0	0.0	0.0
532	0.0	0.0	59.8	0.0	0.0	0.0	0.0
533	0.0	0.0	7.7	0.0	0.0	0.0	0.0
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Annual precipitation

Table 57. Areas (%) in different annual precipitation classes in the sheep and goat breed distribution areas of Morocco

Breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timah-dite (S)	Argane (G)	Atlas and Barcha (G)	Draa (G)
Prec.					(%)				
100-200	0.0	4.3	0.0	3.1	0.0	0.0	0.1	0.0	2.2
200-300	0.0	27.2	0.0	42.0	30.3	0.0	24.7	6.9	14.9
300-400	0.0	53.5	17.2	30.7	61.1	2.2	33.9	23.3	29.1
400-500	19.5	13.8	82.2	21.6	8.6	29.8	27.1	29.2	52.0
500-600	77.9	1.2	0.6	2.3	0.0	42.3	7.7	25.9	1.8
600-700	0.8	0.0	0.0	0.2	0.0	23.7	2.7	10.6	0.0
700-800	0.0	0.0	0.0	0.0	0.0	1.8	1.4	3.0	0.0
800-900	0.0	0.0	0.0	0.0	0.0	0.2	0.7	0.8	0.0
900-1000	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.2	0.0
1000-1100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	35,139	64,821	18,117

Agro-climatic zones

Table 58. Areas (%) in different agro-climatic zones in the sheep and goat breed distribution areas of Morocco

Sheep breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timahdite (S)	Goat breed	Argane (G)	Atlas and Barcha (G)	Draa (G)
ACZ	(%)						ACZ	(%)		
16	0.0	0.0	0.0	3.4	0.0	0.0	17	21.2	1.9	0.0
17	0.0	2.1	0.0	8.2	17.2	0.0	20	0.0	1.0	7.3
19	0.0	0.0	0.0	0.3	0.0	0.0	29	0.0	0.0	39.3
20	0.0	17.9	0.0	6.6	0.0	0.0	30	32.4	3.4	0.5
29	0.0	0.0	0.0	14.1	0.0	0.0	31	0.2	0.0	0.0
30	94.1	2.6	4.9	1.3	74.4	8.7	32	0.0	0.0	13.9
31	0.0	0.0	0.0	0.0	0.0	0.0	33	37.5	71.8	38.9
32	0.0	0.0	0.0	8.7	0.0	0.0	34	3.0	0.0	0.0
33	0.0	77.3	95.1	56.8	8.4	53.3	37	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	46	0.6	14.8	0.0
37	0.0	0.0	0.0	0.0	0.0	0.0	47	4.0	0.1	0.0
43	5.6	0.0	0.0	0.0	0.0	0.0	50	0.0	2.7	0.0
46	0.0	0.1	0.0	0.3	0.0	36.3	51	0.1	3.2	0.0
47	0.0	0.0	0.0	0.0	0.0	0.2	60	0.1	0.0	0.0
50	0.0	0.0	0.0	0.2	0.0	0.1	64	0.8	1.0	0.0
51	0.0	0.0	0.0	0.0	0.0	1.1	77	0.0	0.1	0.0
64	0.0	0.0	0.0	0.0	0.0	0.2				
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	Total breed area (km2)	35,139	64,821	18,117

Landforms

Table 59. Areas (%) in different landform classes in the sheep and goat breed distribution areas of Morocco

Breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timah-dite (S)	Argane (G)	Atlas and Barcha (G)	Draa (G)
Land-form	(%)						(%)		
Plains	90.0	62.0	46.6	49.2	76.1	13.8	23.4	19.5	30.0
Hills	9.8	35.8	53.3	43.6	23.5	75.8	59.0	61.1	64.3
Mountains	0.0	2.1	0.0	7.2	0.3	10.4	17.6	19.4	5.7
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	35,139	64,821	18,117

Land use/land cover

Table 60. Areas (%) in different land use/land cover classes in the sheep and goat breed distribution areas of Morocco

Breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timahdite (S)	Argane (G)	Atlas and Barcha (G)	Draa (G)
LULC	(%)						(%)		
Barren	1.8	94.6	24.8	90.5	26.4	20.6	64.1	62.5	93.1
Forests	52.0	2.1	4.9	0.1	12.3	56.0	7.7	20.8	0.0
Irrigated crops	32.9	0.8	1.3	8.4	4.2	3.0	15.0	2.5	6.2
Rainfed crops	2.1	0.0	15.9	0.0	14.7	3.6	0.9	1.5	0.0
Rangelands	6.6	2.2	52.8	0.6	42.2	16.6	11.0	12.6	0.4
Others	4.0	0.1	0.4	0.3	0.2	0.2	1.4	0.2	0.3
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	35,139	64,821	18,117

Soil management domains

Table 61. Areas (%) in different soil management domains in the sheep and goat breed distribution areas of Morocco

Sheep breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timah-dite (S)	Goat breed	Argane (G)	Atlas and Barcha (G)	Draa (G)
SMD	(%)						SMD	(%)		
00	19.2	0.0	12.2	2.9	12.8	2.1	00	19.7	4.5	0.0
10	51.2	4.6	24.6	0.0	39.5	33.8	10	55.1	11.0	0.0
11	0.0	3.6	0.0	26.1	0.0	0.0	11	6.4	11.6	28.2
12	29.6	0.0	63.2	0.0	4.2	27.1	12	0.0	9.9	0.0
16	0.0	0.3	0.0	0.0	0.0	0.0	16	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	1.2	1.1	18	0.0	0.2	0.0
20	0.0	0.0	0.0	1.2	1.8	0.0	20	7.2	0.0	0.0
28	0.0	0.0	0.0	0.7	0.0	0.0	28	0.0	0.0	3.3
44	0.0	0.0	0.0	4.0	0.0	0.0	44	0.0	0.0	7.2
50	0.0	0.0	0.0	0.0	0.3	28.7	50	3.1	31.1	0.0
57	0.0	0.0	0.0	0.2	0.0	0.0	60	0.5	0.9	0.0
58	0.0	0.5	0.0	0.0	0.0	0.0	62	0.0	23.4	0.0
60	0.0	0.7	0.0	0.0	22.9	0.0	66	0.0	7.5	0.0
62	0.0	24.9	0.0	0.0	0.0	7.3	68	8.0	0.0	0.0
66	0.0	41.2	0.0	0.0	0.0	0.0	70	0.0	0.0	0.0
70	0.0	24.2	0.0	1.2	0.0	0.0	72	0.0	0.0	61.3
72	0.0	0.0	0.0	59.4	0.0	0.0				
80	0.0	0.0	0.0	0.0	9.8	0.0				
81	0.0	0.0	0.0	0.0	7.5	0.0				
DS5	0.0	0.0	0.0	4.2	0.0	0.0				
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	Total breed area (km2)	35,139	64,821	18,117

Agro-ecological zones

Table 62. Areas (%) in different agro-ecological zones in the sheep and goat breed distribution areas of Morocco

Sheep breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timah-dite (S)	Goat breed	Argane (G)	Atlas and Barcha (G)	Draa (G)
AEZ	(%)						AEZ	(%)		
131	0.0	0.0	0.0	5.6	0.0	0.0	131	0.0	0.0	11.3
132	0.0	0.0	0.0	0.7	0.0	0.0	132	0.0	0.0	5.8
221	0.0	0.0	0.0	0.0	8.5	0.0	210	6.6	0.0	0.0
222	0.0	0.0	0.0	0.0	1.4	0.0	221	0.4	0.0	0.0
231	0.0	5.0	1.6	11.7	63.2	0.0	231	14.9	4.4	11.8
232	0.0	0.8	0.0	10.0	12.9	0.0	232	32.2	0.0	10.7
321	0.0	0.0	0.0	0.0	1.3	0.0	310	1.8	0.0	0.0
331	0.0	55.7	0.0	26.7	2.1	0.6	331	0.0	8.4	1.8
332	0.0	24.2	0.0	42.3	0.0	0.1	332	27.4	16.3	58.6
333	0.0	0.0	0.0	2.8	0.0	0.0	333	0.4	1.5	0.0
410	19.2	0.0	0.0	0.0	0.0	0.0	432	0.0	0.8	0.0
421	0.0	0.0	0.0	0.0	0.3	0.0	522	0.0	0.4	0.0
431	74.1	0.0	0.0	0.0	2.5	0.2	531	0.0	2.7	0.0
432	6.6	0.0	0.0	0.0	1.9	7.8	532	5.7	49.0	0.0
521	0.0	0.0	12.2	0.0	1.4	0.0	533	10.5	16.3	0.0
522	0.0	0.0	0.0	0.0	0.0	1.2				
531	0.0	4.0	22.8	0.0	1.0	5.3				
532	0.0	10.2	63.4	0.0	3.6	79.2				
533	0.0	0.0	0.0	0.1	0.1	5.6				
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	Total breed area (km2)	35,139	64,821	18,117

Annual precipitation

Table 63. Areas (%) in different annual precipitation classes in the sheep breed distribution areas of Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkaraman (Kangal)	Akkara man (Kara-kaş)	Akkara man (Norduz)	Ama-sya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
Class (mm)	(%)									
300-400	0.7	0.0	0.0	0.0	0.0	3.3	15.2	0.0	0.0	0.0
400-500	8.1	0.0	7.8	0.0	0.0	20.6	16.1	0.0	0.0	0.0
500-600	26.3	11.7	19.8	0.0	37.4	44.9	22.4	16.0	0.0	0.8
600-700	23.4	51.5	11.9	14.7	35.6	21.3	21.1	33.2	10.1	23.1
700-800	17.4	22.5	11.2	22.3	21.8	7.6	13.4	28.7	66.5	23.8
800-900	9.6	10.1	12.1	26.0	3.5	1.9	6.1	13.7	10.6	22.4
900-1000	5.5	3.4	11.4	16.5	1.4	0.4	3.2	6.2	0.7	23.7
1000-1100	3.2	0.7	11.3	10.7	0.3	0.0	1.0	1.9	0.0	4.9
1100-1200	2.2	0.1	9.5	5.9	0.0	0.0	0.3	0.2	0.0	1.2
1200-1300	1.7	0.0	3.0	2.7	0.0	0.0	0.0	0.0	0.0	0.1
1300-1500	1.5	0.0	1.8	1.1	0.0	0.0	0.0	0.0	0.0	0.0
1500-2000	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
>2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 64. Areas (%) in different annual precipitation classes in the sheep breed distribution areas of Turkey (2)

Sheep breeds	Hemşin	Herik	Karaca-bey Merino	Kara-yaka	Kivirçik	Morka-raman	Ödemiş	Sakiz	Tahi-rova	Tuj
Class (mm)	(%)									
300-400	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	4.1
400-500	0.0	0.7	0.0	0.0	0.0	1.4	0.0	0.0	0.0	3.5
500-600	0.0	19.7	0.0	0.0	1.0	5.3	0.0	0.5	0.7	6.6
600-700	0.0	34.5	4.7	0.3	11.3	13.5	61.1	22.6	24.0	9.8
700-800	0.0	16.2	58.3	4.6	34.5	20.4	28.2	41.6	53.4	10.1
800-900	1.7	10.3	25.5	10.4	24.9	20.0	9.5	17.7	13.4	8.4
900-1000	6.2	8.2	6.3	16.2	12.6	14.8	1.2	7.3	1.4	10.3
1000-1100	9.5	6.3	2.6	16.5	8.3	9.4	0.0	0.3	0.3	11.1
1100-1200	10.9	3.7	1.2	15.3	3.9	6.3	0.0	0.0	0.1	8.8
1200-1300	8.5	0.5	0.5	14.0	0.8	3.2	0.0	0.0	0.0	6.6
1300-1500	17.1	0.0	0.5	13.9	0.1	2.9	0.0	0.0	0.0	8.0
1500-2000	32.8	0.0	0.2	4.9	0.0	1.5	0.0	0.0	0.0	10.0
>2000	12.8	0.0	0.0	1.7	0.0	0.2	0.0	0.0	0.0	2.5
Total breed area (km2)	8,738	8,537	24,212	44,198	95,115	160,167	2,198	33,141	21,865	9,860

Table 65. Areas (%) in different annual precipitation classes in the goat breed distribution areas of Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
Class (mm)	(%)						
300-400	0.0	1.3	0.0	1.8	8.7	0.0	0.0
400-500	0.0	9.2	0.0	5.1	12.4	0.0	0.0
500-600	7.2	35.3	2.0	14.9	13.4	0.3	0.1
600-700	9.0	25.0	4.6	20.1	21.2	21.7	11.7
700-800	8.5	12.6	4.2	19.5	20.9	41.6	16.5
800-900	11.1	6.2	3.9	12.9	9.6	18.9	25.8
900-1000	17.4	4.7	7.4	9.1	9.6	5.4	19.2
1000-1100	21.0	3.1	9.7	5.4	1.5	1.9	12.5
1100-1200	19.5	1.9	9.8	3.9	0.6	0.5	7.6
1200-1300	4.8	0.6	8.5	2.7	0.0	0.1	3.7
1300-1500	1.4	0.2	14.4	2.6	0.0	0.0	2.8
1500-2000	0.1	0.0	25.3	1.2	0.0	0.0	0.2
>2000	0.0	0.0	9.6	0.3	0.0	0.0	0.0
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585

Agro-climatic zones

Table 66. Areas (%) in different agro-climatic zones in the sheep breed distribution areas of Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkaraman (Kangal)	Akkaraman (Kara-kaş)	Akkaraman (Norduz)	Amasya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
ACZ	(%)									
32	0.7	0.0	7.0	0.0	0.0	0.0	13.9	0.0	0.0	0.0
33	17.7	0.0	16.5	0.0	42.3	38.3	29.4	15.6	0.0	0.5
34	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
37	14.3	5.3	0.0	0.0	1.1	33.7	7.2	0.5	0.0	0.2
38	6.0	19.4	0.0	0.0	1.0	2.6	1.0	0.0	0.0	0.0
43	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.1
45	0.1	0.0	0.8	0.0	0.0	0.0	2.0	0.0	0.0	0.0
46	12.0	0.0	15.5	0.0	11.5	6.3	30.4	52.0	89.9	34.5
47	0.5	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.0
50	10.6	4.8	8.0	21.7	0.9	10.3	1.7	5.9	0.0	5.7
51	20.3	65.2	9.9	36.1	40.8	7.9	2.3	9.9	0.0	13.7
56	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
59	1.4	0.0	1.1	0.0	0.0	0.0	6.6	8.1	3.6	22.3
60	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
63	2.3	0.0	13.0	2.5	0.0	0.0	0.8	0.1	0.0	2.8
64	8.5	5.3	11.8	32.5	2.0	0.8	1.2	6.2	0.0	18.4
72	0.9	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
73	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
76	0.3	0.0	8.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0
77	3.6	0.1	8.2	7.2	0.0	0.0	0.2	0.3	0.0	1.7
78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 67. Areas (%) in different agro-climatic zones in the sheep breed distribution areas of Turkey (2)

Sheep breeds	Hemşin	Herik	Karaca-bey Merino	Kara-yaka	Kivirçik	Morka-raman	Ödemiş	Sakiz	Tahiro-va	Tuj
ACZ	(%)									
32	0.0	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	2.0	0.0	0.0	0.8	2.8	0.0	0.2	0.3	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	10.4
38	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	6.4
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0
45	0.0	20.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.0	40.0	78.7	3.8	63.0	2.6	92.9	70.3	92.2	0.0
47	0.0	0.0	0.9	2.1	0.7	0.0	0.0	0.0	0.0	0.0
50	0.3	0.5	0.0	0.4	0.0	22.1	0.0	0.1	0.0	0.0
51	0.3	0.0	0.0	5.4	0.4	20.4	0.0	0.1	0.0	26.1
56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0
59	1.1	5.9	12.2	11.5	20.0	0.0	7.0	18.1	5.3	0.0
60	0.0	0.0	3.6	3.9	3.5	0.0	0.0	0.2	0.3	0.0
63	3.7	14.9	0.0	0.2	0.0	12.8	0.0	0.0	0.0	0.0
64	11.7	0.0	2.0	24.4	4.9	20.2	0.1	0.2	0.3	25.8
72	11.5	0.0	0.0	24.7	4.6	0.0	0.0	0.0	0.0	0.0
73	0.5	0.0	0.0	3.4	0.3	0.0	0.0	0.0	0.0	0.0
76	1.8	8.0	0.0	0.4	0.0	1.7	0.0	0.0	0.0	0.0
77	67.7	0.0	2.5	19.2	1.2	11.3	0.0	0.1	0.2	30.7
78	1.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3
Total breed area (km2)	8,738	8,537	24,212	44,198	95,115	160,167	2,198	33,141	21,865	9860

Table 68. Areas (%) in different agro-climatic zones in the goat breed distribution areas of Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
ACZ	(%)						
32	2.6	0.0	0.0	1.8	1.3	0.0	0.0
33	1.5	22.2	0.0	10.7	29.5	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	0.0	22.1	0.5	7.6	0.0	0.0	0.3
38	0.0	7.8	2.6	3.4	0.0	0.0	0.0
43	0.0	0.0	0.0	0.1	1.6	2.1	0.0
45	2.5	0.0	0.0	0.4	0.0	0.0	0.0
46	15.4	10.7	0.0	18.7	43.8	77.2	0.0
47	0.0	0.5	0.0	0.5	0.0	0.0	0.0
50	4.4	4.8	0.2	9.3	1.4	0.0	22.2
51	0.0	19.6	11.3	16.3	0.0	0.0	24.6
56	0.0	0.0	0.0	0.1	2.2	2.5	0.0
59	2.4	1.9	0.5	4.8	15.9	14.8	0.0
60	0.0	0.7	0.0	0.9	0.0	0.3	0.0
63	34.2	0.0	1.3	3.7	1.3	0.0	7.3
64	3.1	7.5	17.5	11.2	0.9	0.0	33.5
72	0.0	0.1	8.8	2.4	0.9	0.8	0.0
73	0.0	0.0	0.2	0.6	0.0	0.0	0.0
76	23.2	0.0	1.0	0.6	0.1	0.0	0.0
77	10.6	2.0	55.1	6.7	0.4	0.1	12.2
78	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585

Landforms

Table 69. Areas (%) in different landform classes in the sheep breed distribution areas of Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkara man (Kangal)	Akkara man (Kara-kaş)	Akkara man (Norduz)	Amasya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
LF	(%)									
Plain	20.1	13.6	9.0	2.0	7.9	53.9	41.7	14.4	24.6	3.5
Hills	63.4	79.8	53.6	64.3	66.1	42.4	47.3	64.3	64.4	57.0
Mountains	16.5	6.6	37.4	33.7	26.0	3.7	10.6	21.3	4.6	39.5
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 70. Areas (%) in different landform classes in the sheep breed distribution areas of Turkey (2)

Sheep breeds	Hemşin	Herik	Karaca-bey Merino	Kara-yaka	Kivirçik	Morka-raman	Ödemiş	Sakiz	Tahi-rova	Tuj
LF	(%)									
Plain	0.0	8.4	14.5	4.3	23.7	10.6	26.2	18.5	21.1	18.2
Hills	10.5	61.2	76.4	48.8	67.1	60.2	45.8	63.2	69.9	73.4
Mountains	89.3	30.4	9.1	46.6	8.6	29.1	28.0	16.4	7.8	8.1
Total breed area (km2)	8,738	8,537	24,212	44,198	95,115	160,167	2,198	33,141	21,865	9,860

Table 71. Areas (%) in different landform classes in the goat breed distribution areas of Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
LF	(%)						
Plain	3.5	27.1	7.5	15.4	25.3	29.5	2.1
Hills	41.9	66.0	42.6	61.8	54.9	61.9	57.6
Mountains	54.6	6.9	49.6	22.7	19.2	6.6	40.3
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585

Land use/land cover

Table 72. Areas (%) in different land use/land cover classes in the sheep breed distribution areas of Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkara man (Kangal)	Akkara man (Kara-kaş)	Akkara man (Nor-duz)	Amasya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
LULC	(%)									
Barren	6.6	0.5	0.3	0.3	0.0	20.7	9.8	8.8	0.0	10.5
Forests	11.1	0.0	0.5	0.0	31.0	1.0	17.8	22.1	61.8	17.8
Irrigated crops	7.9	0.1	4.3	0.1	1.3	7.2	15.1	29.2	17.2	22.6
Rainfed crops	24.7	14.6	8.7	17.9	59.4	25.6	22.9	26.1	2.6	15.4
Rangelands	47.9	84.6	85.2	81.6	8.2	43.2	32.6	11.7	0.6	33.6
Others	1.8	0.1	1.0	0.0	0.1	2.2	1.3	2.1	10.1	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 73. Areas (%) in different land use/ land cover classes in the sheep breed distribution areas of Turkey (2)

Sheep breeds	Hemşin	Herik	Karaca-bey Merino	Kara-yaka	Kivirçik	Morka-raman	Ödemi ş	Sakiz	Tahiro-va	Tuj
LULC	(%)									
Barren	1.1	0.3	0.1	0.1	0.9	1.5	0.0	0.4	0.5	0.8
Forests	12.6	0.0	78.5	37.4	61.1	1.3	64.4	51.3	61.5	0.6
Irrigated crops	36.4	0.5	15.3	19.2	16.9	0.5	35.1	33.2	24.4	2.1
Rainfed crops	3.9	13.2	3.8	11.6	14.4	14.3	0.1	5.2	4.0	43.1
Rangelands	44.7	80.8	0.1	24.0	2.3	79.0	0.0	1.9	1.0	51.2
Others	0.8	5.1	2.1	6.0	3.3	3.4	0.4	4.8	6.2	1.8
Total breed area (km2)	8,738	8,537	24,212	44,198	95,115	160,167	2,198	33,141	21,865	9,860

Table 74. Areas (%) in different land use/ land cover classes in the goat breed distribution areas of Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
LULC	(%)						
Barren	0.2	10.3	0.5	4.2	7.2	0.4	0.2
Forests	4.6	11.8	7.8	17.7	35.3	47.1	0.0
Irrigated crops	0.6	9.0	21.5	11.4	17.8	23.7	0.1
Rainfed crops	10.6	33.4	24.4	20.7	12.1	14.4	19.0
Rangelands	81.3	33.9	43.3	43.7	25.7	3.6	79.7
Others	2.6	1.6	1.9	2.1	1.2	7.3	0.8
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585

Soil management domains

Table 75. Areas (%) in different soil management domains the sheep breed distribution areas of Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkara man (Kangal)	Akkara man (Kara-kaş)	Akkara man (Norduz)	Amasya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
SMD					(%)					
00	26.9	5.2	12.9	16.7	75.7	18.6	27.1	46.6	16.9	14.0
10	18.5	7.4	28.9	0.0	24.2	8.0	31.1	34.9	83.1	1.3
11	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	7.3	3.7	13.3	0.0	0.0	0.0	3.7	0.0	0.0	26.0
16	0.6	0.0	9.0	33.2	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.5	0.0	0.0
26	2.2	0.0	0.0	0.0	0.0	9.7	0.7	1.5	0.0	0.0
40	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	6.4	0.0	0.0	0.0	0.0	1.6	7.1	12.3	0.0	56.7
60	28.1	81.0	0.0	0.0	0.0	54.6	11.0	2.5	0.0	0.6
61	2.2	0.0	3.1	0.0	0.0	0.0	14.8	0.0	0.0	0.0
80	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88	4.3	2.7	32.1	50.2	0.1	7.5	3.1	0.0	0.0	0.0
90	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	1.3
WR	0.7	0.0	0.7	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 76. Areas (%) in different soil management domains in the sheep breed distribution areas of Turkey (2)

Sheep breeds	Hemşin	Herik	Karaca-bey Merino	Kara-yaka	Kivirçik	Morka-raman	Ödemiş	Sakiz	Tahiro-va	Tuj
SMD	(%)									
00	52.4	2.5	4.3	54.4	21.2	14.9	38.6	33.7	19.5	40.2
10	0.0	57.4	87.9	21.4	65.2	31.5	38.1	40.1	58.8	32.3
11	0.0	0.0	0.0	15.2	1.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.1	0.0	0.6	0.0	0.0	0.0	0.0
15	31.0	30.7	0.0	0.2	0.0	22.4	0.0	1.2	0.0	26.7
16	0.0	0.0	0.0	0.0	0.0	8.1	0.0	0.0	0.0	0.0
20	0.0	0.0	2.8	0.0	3.4	0.0	11.2	3.7	5.4	0.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	16.4	0.0	5.0	8.7	9.1	0.3	12.1	21.2	16.3	0.7
60	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0
61	0.0	6.5	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
68	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
88	0.1	2.9	0.0	0.0	0.0	12.9	0.0	0.0	0.0	0.0
WR	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0
Total breed area (km2)	8,738	8,537	24,212	44,198	95,115	160,167	2,198	33,141	21,865	9,860

Table 77. Areas (%) in different soil management domains in the goat breed distribution areas of Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
SMD	(%)						
00	12.6	32.9	50.1	29.7	29.2	33.1	27.1
10	15.8	19.2	11.5	26.5	43.3	51.2	0.0
11	0.0	0.4	0.0	2.1	0.0	0.0	0.0
12	0.0	0.0	0.0	0.2	0.0	0.0	0.0
15	25.3	0.2	29.3	9.3	10.4	0.0	0.0
16	0.5	0.0	0.0	1.9	0.0	0.0	22.2
20	0.0	0.0	0.0	0.3	1.2	4.3	0.0
26	0.0	4.0	0.0	0.7	0.0	0.0	0.0
40	0.0	0.3	0.0	0.2	0.0	0.0	0.0
50	0.0	1.8	9.1	6.8	5.0	11.4	0.0
60	0.0	34.7	0.0	13.6	0.9	0.0	0.0
61	2.2	0.0	0.0	2.3	8.8	0.0	0.0
68	4.2	0.0	0.0	0.2	0.0	0.0	0.0
80	0.0	0.8	0.0	0.3	0.0	0.0	0.0
88	35.5	4.7	0.1	5.0	0.0	0.0	48.3
90	0.0	0.0	0.0	0.1	1.2	0.0	0.0
WR	4.0	0.9	0.0	0.7	0.0	0.0	2.4
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585

Agro-ecological zones

Table 78. Areas (%) in different agro-ecological zones in the sheep breed distribution areas of Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkara-man (Kangal)	Akkara-man (Kara-kaş)	Akkara-man (Norduz)	Amasya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
AEZ	(%)									
310	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0
321	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0
331	1.7	0.0	0.0	0.0	0.0	11.1	5.1	0.0	0.0	0.0
332	0.1	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
410	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
510	3.2	0.0	2.1	0.0	0.0	2.6	8.4	23.0	15.9	11.6
521	2.9	0.0	0.0	0.0	0.0	11.5	8.2	6.0	0.0	0.0
522	4.1	0.0	0.0	0.0	70.2	2.2	1.4	10.0	0.0	0.1
523	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
531	9.4	0.0	1.9	0.0	0.0	29.1	16.4	8.7	15.8	0.0
532	34.7	9.6	46.6	12.4	7.8	36.3	45.2	31.3	61.9	23.4
533	3.0	0.0	0.0	0.0	0.0	0.0	2.1	5.1	0.0	5.9
610	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
621	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
622	10.0	4.7	0.0	0.0	5.5	2.3	0.7	3.3	0.0	0.0
623	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
631	0.3	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
632	13.7	78.5	12.3	45.6	16.5	3.3	1.4	4.9	0.0	18.0
633	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
810	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
822	2.6	0.5	3.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0
833	3.1	0.0	32.2	27.1	0.0	0.0	3.3	0.5	0.0	23.7
1010	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1032	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1033	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1310	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1332	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1333	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 79. Areas (%) in different agro-ecological zones in the sheep breed distribution areas of Turkey (2)

Sheep breeds	Hemşin	Herik	Karaca-bey Merino	Kara-yaka	Kivirçik	Morka-raman	Ödemiş	Sakiz	Tahirova	Tuj
AEZ	(%)									
310	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
321	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
331	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	1.0
332	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	3.8
410	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
510	0.0	0.0	2.4	0.0	6.0	0.0	32.0	19.7	18.0	0.0
521	0.0	2.5	0.0	0.0	7.4	0.0	0.0	1.2	0.0	0.0
522	0.0	0.0	0.0	2.4	4.1	0.5	0.0	0.7	0.8	0.0
523	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0
531	0.0	0.5	7.1	0.0	7.2	5.2	0.0	2.4	8.6	0.0
532	0.0	86.3	79.0	1.9	42.8	31.6	61.4	50.5	70.7	4.1
533	0.0	0.0	0.0	0.7	0.0	3.5	6.6	10.0	0.0	0.0
610	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
621	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
622	0.0	0.0	0.0	0.0	0.8	0.7	0.0	0.0	0.0	4.8
623	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
631	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	2.8
632	0.0	0.0	1.9	9.8	1.4	26.1	0.0	0.0	0.0	37.1
633	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
810	1.1	0.0	0.0	13.3	0.6	0.0	0.0	5.7	0.0	0.0
822	0.0	0.0	0.0	7.0	0.0	4.7	0.0	0.0	0.0	29.3
833	51.0	9.3	1.9	22.7	2.1	8.9	0.0	1.8	0.5	1.0
1010	9.4	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0
1022	1.5	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	6.1
1032	0.0	0.0	0.0	8.9	0.0	0.5	0.0	0.0	0.0	0.0
1033	9.3	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
1310	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1332	2.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.7
1333	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	8,738	8,537	24,212	44,198	95,115	160,167	2,198	33,141	21,865	9,860

Table 80. Areas (%) in different agro-ecological zones in the goat breed distribution areas of Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
AEZ				(%)			
310	0.0	0.0	0.0	0.2	0.5	0.0	0.0
321	0.0	0.0	0.0	0.3	2.9	0.0	0.0
331	0.0	3.2	0.0	1.4	2.0	0.0	0.0
332	0.0	0.2	0.0	0.3	0.0	0.0	0.0
510	0.0	2.4	0.0	5.4	16.6	17.1	0.0
521	0.0	5.9	0.0	2.5	1.2	1.2	0.0
522	0.0	4.3	0.0	3.6	2.3	8.5	0.0
523	0.0	0.0	0.0	0.4	0.0	0.0	0.0
531	5.4	11.7	0.0	6.3	6.6	12.4	2.4
532	33.8	33.8	1.7	31.4	50.3	43.4	11.3
533	0.0	0.0	0.0	2.8	3.5	3.4	0.0
610	0.0	0.8	0.0	0.2	0.0	0.0	0.0
621	0.0	0.2	0.0	0.0	0.0	0.0	0.0
622	0.0	16.4	0.8	5.9	0.0	0.0	0.0
623	0.0	0.0	0.0	0.2	0.0	0.0	0.0
631	0.0	0.1	1.4	0.2	0.0	0.0	0.0
632	0.0	9.5	12.6	13.9	0.0	0.0	29.7
633	0.0	0.0	0.0	1.0	0.0	0.0	0.0
810	0.0	0.3	1.5	1.3	0.0	2.7	0.0
822	2.0	2.2	17.6	2.8	0.0	0.0	15.3
823	0.1	0.0	0.0	0.9	0.0	0.0	1.3
831	0.0	0.0	0.0	0.1	0.0	0.0	0.0
832	16.1	8.6	5.7	9.3	2.9	9.3	6.4
833	42.7	0.3	27.3	6.2	10.9	0.0	33.5
1010	0.0	0.0	8.9	0.6	0.0	0.0	0.0
1022	0.0	0.0	3.9	0.1	0.0	0.0	0.0
1032	0.0	0.0	2.0	1.5	0.0	0.0	0.0
1033	0.0	0.0	4.1	0.5	0.0	0.0	0.0
1310	0.0	0.0	5.2	0.1	0.0	0.0	0.0
1332	0.0	0.0	2.1	0.1	0.0	0.0	0.0
1333	0.0	0.0	5.0	0.1	0.0	0.0	0.0
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585

ANNEX 3. COMPARISON OF BREED AREA CHARACTERIZATIONS USING DAD-IS AND ICARDA DATASETS[12]

EGYPT

Annual precipitation

Table 81. Annual precipitation difference table between ICARDA and DAD-IS layers for the sheep areas in Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indige-nous (Baladi)	Ossimi	Rahmani	Saidi / Shana-bawi	Sohagi
Annual precipitation class (mm)	(%)							
0-100	-8.7	0.6	0.0	-13.7	5.2	-23.2	0.4	0.0
100-200	7.6	-0.6	0.0	13.4	-5.2	21.8	-0.4	0.0
200-300	1.1	0.0	0.0	0.3	0.0	1.4	0.0	0.0
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 82. Annual precipitation difference table between ICARDA and DAD-IS layers for the goat areas in Egypt

Goat breeds	Aburamad, Halaieb, Shalatin	Barki	Black Sinai	Indige-nous (Baladi)	Saidi	Wahati	Zaraibi
Annual precipitation class (mm)	(%)						
0-100	-8.7	0.5	-29.0	-2.5	0.0	0.0	0.1
100-200	7.6	-0.5	28.8	2.3	0.0	0.0	-0.1
200-300	1.1	0.0	0.3	0.1	0.0	0.0	0.0
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

[12] Positive values in the difference tables indicate that the ICARDA layer has a higher value than the DAD-IS layer in the specific thematic class, negative values that the DAD-IS layer has a higher value. A green background indicates a positive difference of more than 20%, an orange background a negative difference of more than 20%.

Maximum temperature of the warmest month

Table 83. Maximum temperature difference table between ICARDA and DAD-IS layers for the sheep areas in Egypt

Sheep breeds	Abudeleik / Kanzi / Maenit	Barki	Farafra	Indige-nous (Baladi)	Ossimi	Rahmani	Saidi / Shana-bawi	Sohagi
Temp	(%)							
27.5 - 30	0.1	5.3	0.0	0.5	0.0	0.0	0.0	0.0
30 - 32.5	-8.1	-5.3	0.0	-6.6	1.1	-15.4	-0.1	0.0
32.5 - 35	-67.6	0.0	9.5	-5.9	-0.3	15.4	5.4	0.0
35 - 37.5	73.5	0.0	2.1	13.9	-0.7	0.0	4.6	12.2
37.5 - 40	2.0	0.0	-11.7	-2.0	0.0	0.0	-4.6	1.7
40 - 42.5	0.0	0.0	0.0	0.0	0.0	0.0	-5.3	-13.8
42.5 - 45.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150	34,724

Table 84. Maximum temperature difference table between ICARDA and DAD-IS layers for the goat areas in Egypt

Goat breeds	Abura-mad, Halaieb, Shalatin	Barki	Black Sinai	Indige-nous (Baladi)	Saidi	Wahati	Zaraibi
Class (°C)				(%)			
25 - 27.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0
27.5 - 30	0.1	5.8	1.3	0.0	0.0	0.0	0.0
30 - 32.5	-3.1	-5.8	-9.7	-1.8	0.2	0.0	-39.2
32.5 - 35	-75.4	0.0	0.7	5.8	5.5	10.0	36.1
35 - 37.5	76.5	0.0	7.6	2.8	4.0	-1.7	3.0
37.5 - 40	2.0	0.0	0.0	-2.4	-3.6	-2.7	0.0
40 - 42.5	0.0	0.0	0.0	-4.3	-6.2	-5.6	0.0
42.5 - 45.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	21,745	12,554	4,653	155,987	12,451	11,343	79,150

Table 85. Annual precipitation difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Farahani	Fashan-di	Ghash-ghaye	Ghezel
Annual precipitation class (mm)					(%)				
<100	0.0	0.0	0.0	33.0	0.1	0.0	0.0	0.0	0.0
100-200	0.0	50.9	0.0	27.8	0.0	0.0	0.0	3.4	0.0
200-300	0.0	16.2	40.1	-49.0	-5.2	35.4	3.1	42.8	0.0
300-400	48.5	-47.9	-48.3	-11.9	-15.2	17.2	14.7	-41.6	25.6
400-500	-25.0	-17.7	-4.4	-0.2	15.3	-53.1	-5.6	-8.5	2.3
500-600	-15.8	-3.3	9.8	0.2	4.5	0.4	-5.4	3.1	-26.8
600-700	-8.0	0.1	2.3	0.1	0.3	0.0	-10.1	0.6	-6.1
700-800	0.3	0.0	0.4	0.0	0.1	0.0	-3.9	0.1	2.4
800-900	0.1	0.0	0.2	0.0	0.0	0.0	4.0	0.0	1.6
900-1000	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.6
1000-1100	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.1
1100-1200	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 86. Annual precipitation difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (2)

Sheep breeds	Gray shiraz	Kalkouhi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Annual precipitation class (mm)	(%)								
<100	0.0	0.0	0.0	12.9	0.1	0.0	0.0	0.9	0.0
100-200	17.9	30.4	-0.9	-7.8	0.0	0.0	0.0	1.3	0.0
200-300	-17.9	25.9	-4.3	-6.5	-18.9	0.4	1.1	-26.8	-4.1
300-400	-2.2	-56.2	5.2	1.2	-17.1	-28.1	20.4	-6.5	-11.6
400-500	2.1	-3.6	0.0	0.2	28.1	-11.4	-29.4	16.2	-11.7
500-600	0.0	0.2	0.0	0.0	6.8	32.7	7.0	10.5	7.4
600-700	0.0	1.8	0.0	0.0	1.0	6.0	0.7	3.3	10.6
700-800	0.0	1.0	0.0	0.0	0.0	0.1	0.1	0.9	5.2
800-900	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.2	2.5
900-1000	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1
1000-1100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
1100-1200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 87. Annual precipitation difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (3)

Sheep breeds	Mehra-bani	Moghani	Naeini	Sangsari	Sanjabi	Shal	Taleshi	Zandi	Zel
Annual precipitation class (mm)	(%)								
<100	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0
100-200	0.0	0.0	-9.0	-8.0	0.0	0.3	0.0	24.1	-17.9
200-300	10.4	0.1	-5.5	0.1	1.1	29.7	0.0	0.3	-23.8
300-400	-19.6	10.2	3.2	0.7	2.7	-17.2	0.0	-37.5	-5.6
400-500	7.9	0.7	3.8	3.4	-26.7	-3.7	-0.4	2.6	4.2
500-600	0.0	-16.7	1.2	1.9	21.0	-9.7	-2.1	3.7	11.2
600-700	0.5	0.5	0.2	1.1	1.7	-2.0	-4.7	3.2	11.4
700-800	0.3	2.9	0.0	0.6	0.1	2.0	-4.3	2.1	8.4
800-900	0.4	1.2	0.0	0.2	0.0	0.0	-5.3	0.8	5.5
900-1000	0.2	0.5	0.0	0.1	0.0	0.6	-1.6	0.4	2.5
1000-1100	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.1	1.2
1100-1200	0.0	0.1	0.0	0.0	0.0	0.0	1.3	0.0	1.4
1200-1300	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.9
1300-1500	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0	0.1
1500-2000	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 88. Annual precipitation difference table between ICARDA and DAD-IS layers for the goat areas in Iran

Goat breeds	Adani	Birjandi (Balou-chi)	Marghoz	Nado-shan	Najdi	Raeini	Tali
Annual precipitation class (mm)	(%)						
<100	0.0	14.1	0.0	0.4	0.0	14.0	7.0
100-200	44.3	-16.9	0.0	-3.1	44.2	-9.5	1.5
200-300	-48.4	2.5	0.0	2.3	-46.8	-6.3	-9.9
300-400	0.3	0.3	-26.1	0.3	0.3	1.3	0.1
400-500	0.0	0.0	-38.0	0.1	0.0	0.2	0.0
500-600	0.0	0.0	50.9	0.0	0.0	0.0	0.0
600-700	0.0	0.0	12.7	0.0	0.0	0.0	0.0
700-800	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Maximum temperature of the warmest month

Table 89. Maximum temperature difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Farahani	Fashan-di	Ghash-ghaye	Ghezel
Class (°C)	(%)								
17.5 - 20	0.0	0.0	0.0	0.0	0.2	0.0	0.9	0.0	0.4
20 - 22.5	0.3	0.0	0.1	0.0	0.5	0.0	3.7	0.0	2.0
22.5 - 25	1.0	0.0	0.4	0.2	3.8	0.0	7.8	0.1	5.1
25 - 27.5	3.5	0.0	1.0	0.6	7.1	0.3	15.3	0.7	8.1
27.5 - 30	4.7	0.1	4.5	1.9	1.2	2.4	-2.7	5.8	6.8
30 - 32.5	-16.3	0.3	11.4	3.3	12.8	18.7	-23.1	16.3	-23.7
32.5 - 35	3.2	0.8	-11.8	0.4	12.6	28.3	-14.7	-15.5	-0.7
35 - 37.5	3.6	-1.5	-10.2	-7.2	-38.1	-49.7	12.7	-20.1	1.8
37.5 - 40	0.0	-14.9	-34.3	-21.4	0.0	0.0	0.0	-7.5	0.0
40 - 42.5	0.0	10.8	16.5	15.5	0.0	0.0	0.0	12.7	0.0
42.5 - 45.5	0.0	4.4	22.5	6.8	0.0	0.0	0.0	7.5	0.0
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 90. Maximum temperature difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (2)

Sheep breeds	Gray shiraz	Kalkouhi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Class (°C)	(%)								
17.5 - 20	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.5
20 - 22.5	0.0	0.3	0.0	0.1	1.8	0.0	0.0	0.0	2.3
22.5 - 25	0.0	0.8	0.0	0.4	7.6	0.0	0.0	0.3	8.1
25 - 27.5	0.0	2.2	0.0	1.7	16.6	0.3	0.5	1.5	3.1
27.5 - 30	0.6	0.8	0.2	4.6	14.8	4.4	2.1	7.2	-10.4
30 - 32.5	4.6	2.8	1.9	3.0	-8.7	19.0	13.9	14.5	-10.2
32.5 - 35	3.6	-4.6	-10.1	-2.6	-35.5	-16.7	13.3	-15.5	3.5
35 - 37.5	-38.1	-13.5	-20.4	-14.6	3.2	0.0	-20.9	-9.8	2.9
37.5 - 40	-4.8	-8.2	28.4	-10.0	0.1	-3.3	-10.0	-0.1	0.0
40 - 42.5	29.7	19.5	0.0	0.1	0.0	0.2	-0.9	-4.7	0.0
42.5 - 45.5	4.5	0.0	0.0	17.3	0.0	-3.9	2.0	6.6	0.0
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 91. Maximum temperature difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (3)

Sheep breeds	Mehra-bani	Moghani	Naeini	Sangsari	Sanjabi	Shal	Taleshi	Zandi	Zel
Class (°C)	(%)								
10 - 12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
12.5 - 15	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0
15 - 17.5	0.0	0.4	0.0	0.0	0.0	0.0	0.6	0.0	0.1
17.5 - 20	0.0	1.3	0.0	0.0	0.0	0.0	1.0	0.1	0.5
20 - 22.5	0.0	4.9	0.0	0.3	0.0	0.4	3.5	0.9	2.4
22.5 - 25	0.0	12.2	0.0	1.1	0.0	1.3	12.4	2.4	7.1
25 - 27.5	0.3	9.5	0.6	3.3	0.5	3.3	10.5	5.4	8.0
27.5 - 30	3.1	-11.8	3.4	4.0	1.6	5.2	-11.9	2.1	-2.1
30 - 32.5	21.2	-23.4	9.8	0.2	8.6	-9.3	-16.9	1.1	5.5
32.5 - 35	-12.0	6.4	1.3	-10.0	14.9	-8.6	0.4	-11.3	-10.7
35 - 37.5	-13.9	0.4	-17.9	-9.7	-11.1	4.3	0.0	-11.1	-10.9
37.5 - 40	1.2	0.0	-22.9	-17.6	-8.6	3.2	0.0	-2.8	0.0
40 - 42.5	0.1	0.0	25.6	28.4	-1.0	0.1	0.0	13.2	0.0
42.5 - 45.5	0.0	0.0	0.0	0.0	-4.9	0.0	0.0	0.0	0.0
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

Table 92. Maximum temperature difference table between ICARDA and DAD-IS layers for the goat areas in Iran

Goat breeds	Adani	Birjandi (Balou-chi)	Marghoz	Nado-shan	Najdi	Raeini	Tali
Class (°C)	(%)						
20 - 22.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0
22.5 - 25	0.0	0.0	0.0	0.1	0.0	0.5	0.0
25 - 27.5	0.0	0.2	0.5	0.3	0.0	1.8	0.0
27.5 - 30	0.0	1.7	10.4	1.7	0.0	4.5	0.0
30 - 32.5	0.0	4.0	28.1	5.2	0.0	1.2	0.2
32.5 - 35	0.0	1.5	-29.2	5.5	0.0	-6.7	-0.9
35 - 37.5	-21.1	-9.4	-10.1	-12.5	0.0	-13.2	-38.2
37.5 - 40	-55.6	-21.8	0.3	-20.2	-2.6	-15.0	-19.0
40 - 42.5	55.2	16.0	0.0	19.9	-23.4	2.9	40.7
42.5 - 45.5	21.4	7.8	0.0	0.0	25.9	24.0	17.3
Total breed area (km2)	24,901	249,110	17,997	43,722	33,639	177,637	119,396

Table 93. Köppen class difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (1)

Sheep breeds	Afshari	Arabi	Bahmei	Baluchi	Dalagh	Faraha-ni	Fashan-di	Ghash-ghaye	Ghezel
Köppen class	(%)								
BWh	0.0	7.3	-7.6	23.4	0.0	0.0	0.0	11.4	0.0
BWk	0.0	0.0	0.2	36.4	24.4	26.1	13.1	14.5	0.0
BSh	0.0	-13.5	-50.2	-2.0	0.0	-59.0	0.0	-43.6	0.0
BSk	94.3	5.9	52.1	-57.9	-24.7	32.9	52.9	16.1	77.8
Csa	-99.1	0.2	2.5	0.0	0.0	0.0	-85.0	0.7	-58.7
Cfa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Dsa	4.8	0.1	3.1	0.1	0.4	0.0	19.0	0.8	-20.2
Dfa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	37,364	80,704	11,915	424,973	8,887	13,872	7,292	57,986	55,318

Table 94. Köppen class difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (2)

Sheep breeds	Gray shiraz	Kalkou-hi	Karakul (Black)	Kermani	Kord Khora-sani	Kurdi Kurde-stan	Lory	Lory Bakhti-yari	Makui
Köppen class	(%)								
BWh	31.9	8.2	0.0	33.1	0.0	2.4	-34.2	-32.9	0.0
BWk	27.3	53.8	76.8	44.7	21.8	0.0	0.0	-6.5	-4.9
BSh	-49.0	-14.3	0.0	-23.0	0.0	-31.9	-55.0	-6.5	0.0
BSk	-10.3	-34.3	-76.8	-54.8	-22.2	53.5	83.0	38.5	45.2
Csa	0.0	-15.4	0.0	0.0	0.0	-43.2	2.8	0.8	0.0
Cfa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Dsa	0.0	2.1	0.0	0.0	0.5	19.2	3.4	6.6	-46.2
Dfa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	65,040	29,236	5,514	185,367	24,809	43,204	39,327	85,169	23,633

Table 95. Köppen class difference table between ICARDA and DAD-IS layers for the sheep areas in Iran (3)

Sheep breeds	Mehra-bani	Mogha-ni	Naeini	Sangsa-ri	Sanjabi	Shal	Taleshi	Zandi	Zel
Köppen class					(%)				
BWh	0.0	0.0	40.5	36.7	3.2	0.0	0.0	11.5	0.0
BWk	6.9	0.7	-17.3	42.4	0.0	28.3	0.0	38.8	9.7
BSh	-48.4	0.0	-1.7	0.0	-84.1	0.0	0.0	-7.1	0.0
BSk	81.3	73.9	-21.8	-79.9	66.2	45.8	36.5	-39.4	-12.9
Csa	-40.6	-52.0	0.0	-0.2	11.5	-77.2	-78.1	-8.0	-7.8
Cfa	0.0	1.4	0.0	0.0	0.0	0.0	28.1	0.0	1.6
Dsa	0.8	-28.6	0.2	1.0	3.2	3.0	12.1	4.2	9.4
Dfa	0.0	4.5	0.0	0.0	0.0	0.0	1.2	0.0	0.0
E	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.1
Total breed area (km2)	47,211	46,834	101,314	103,885	29,461	26,667	19,334	46,115	30,514

MOROCCO

Table 96. Annual precipitation difference table between ICARDA and DAD-IS layers for the sheep and goat areas in Morocco

Breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timah-dite (S)	Argane (G)	Atlas and Barcha (G)	Draa (G)
Prec.	(%)						(%)		
0-100	0	0	0	-21	0	0	0	0	-36
100-200	0	-1	0	-44	0	0	-4	0	-51
200-300	0	9	0	22	12	0	-16	6	5
300-400	0	8	17	22	-3	2	-7	10	29
400-500	20	-16	82	20	-4	21	17	-1	52
500-600	25	1	-87	0	-5	11	5	2	2
600-700	-47	0	-13	0	0	-11	1	-9	0
700-800	0	0	0	0	0	-15	1	-8	0
800-900	0	0	0	0	0	-7	1	0	0
900-1000	0	0	0	0	0	-2	0	0	0
1000-1100	0	0	0	0	0	0	0	0	0
1100-1200	0	0	0	0	0	0	0	0	0
1200-1300	0	0	0	0	0	0	0	0	0
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	35,139	64,821	18,117

Table 97. Maximum temperature difference table between ICARDA and DAD-IS layers for the sheep and goat areas in Morocco

Breed	Beni Ahsen (S)	Beni Guil (S)	Boujaad (S)	D'man (S)	Sardi (S)	Timahdite (S)	Argane (G)	Atlas and Barcha (G)	Draa (G)
Temp	(%)						(%)		
22.5 - 25	0.0	0.0	0.0	0.0	-0.9	0.0	-3.7	0.0	0.0
25 - 27.5	0.0	0.0	0.0	0.0	4.8	0.1	-7.8	0.2	0.0
27.5 - 30	-68.3	0.0	0.0	0.0	-5.5	-15.5	-1.1	-9.1	0.0
30 - 32.5	60.0	-13.8	0.0	-0.9	-11.3	-30.0	4.6	-27.5	0.0
32.5 - 35	8.3	-24.5	-17.9	-6.4	4.5	37.0	6.7	18.1	0.0
35 - 37.5	0.0	15.4	17.9	-20.0	-1.3	8.4	1.3	16.3	-14.8
37.5 - 40	0.0	22.9	0.0	6.8	9.7	0.1	0.0	2.0	-29.3
40 - 42.5	0.0	0.0	0.0	16.1	0.0	0.0	0.0	0.0	31.0
42.5 - 45.5	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	13.2
Total breed area (km2)	5,794	58,863	2,669	28,434	38,422	31,813	35,139	64,821	18,117

TURKEY

Table 98. Annual precipitation difference table between ICARDA and DAD-IS layers for the sheep areas in Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkara-man (Kangal)	Akkara-man (Kara-kaş)	Akkara-man (Nordu z)	Ama-sya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
Class (mm)	(%)									
200-300	-0.3	0.0	0.0	0.0	0.0	-2.4	0.0	0.0	0.0	0.0
300-400	-15.8	0.0	0.0	0.0	0.0	-63.7	2.3	0.0	0.0	0.0
400-500	-25.1	-92.3	1.7	-23.1	-100.0	1.4	-4.9	-6.1	-8.6	0.0
500-600	1.1	4.0	-10.8	-38.5	37.4	34.7	-5.2	-20.6	-34.5	-5.5
600-700	9.6	51.5	-12.6	-23.8	35.6	20.1	6.7	6.1	-3.7	-14.4
700-800	10.4	22.5	-5.1	22.3	21.8	7.6	-1.4	8.4	38.9	-32.5
800-900	7.3	10.1	4.0	26.0	3.5	1.9	-0.9	7.2	5.4	22.4
900-1000	4.4	3.4	1.2	16.5	1.4	0.4	0.8	2.8	-6.2	23.7
1000-1100	2.8	0.7	7.2	10.7	0.3	0.0	1.0	1.9	-3.4	4.9
1100-1200	2.2	0.1	9.5	5.9	0.0	0.0	0.3	0.2	0.0	1.2
1200-1300	1.7	0.0	3.0	2.7	0.0	0.0	0.0	0.0	0.0	0.1
1300-1500	1.5	0.0	1.8	1.1	0.0	0.0	0.0	0.0	0.0	0.0
1500-2000	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 99. Annual precipitation difference table between ICARDA and DAD-IS layers for the sheep areas in Turkey (2)

Sheep breeds	Akkara-man (com-mon)	Akkaram an (Kangal)	Akkara man (Kara-kaş)	Akkara man (Nordu z)	Ama-sya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
Class (mm)	(%)									
200-300	-0.3	0.0	0.0	0.0	0.0	-2.4	0.0	0.0	0.0	0.0
300-400	-15.8	0.0	0.0	0.0	0.0	-63.7	2.3	0.0	0.0	0.0
400-500	-25.1	-92.3	1.7	-23.1	-100.0	1.4	-4.9	-6.1	-8.6	0.0
500-600	1.1	4.0	-10.8	-38.5	37.4	34.7	-5.2	-20.6	-34.5	-5.5
600-700	9.6	51.5	-12.6	-23.8	35.6	20.1	6.7	6.1	-3.7	-14.4
700-800	10.4	22.5	-5.1	22.3	21.8	7.6	-1.4	8.4	38.9	-32.5
800-900	7.3	10.1	4.0	26.0	3.5	1.9	-0.9	7.2	5.4	22.4
900-1000	4.4	3.4	1.2	16.5	1.4	0.4	0.8	2.8	-6.2	23.7
1000-1100	2.8	0.7	7.2	10.7	0.3	0.0	1.0	1.9	-3.4	4.9
1100-1200	2.2	0.1	9.5	5.9	0.0	0.0	0.3	0.2	0.0	1.2
1200-1300	1.7	0.0	3.0	2.7	0.0	0.0	0.0	0.0	0.0	0.1
1300-1500	1.5	0.0	1.8	1.1	0.0	0.0	0.0	0.0	0.0	0.0
1500-2000	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 100. Annual precipitation difference table between ICARDA and DAD-IS layers for the goat areas in Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
Class (mm)				(%)			
200-300	0.0	-0.5	0.0	-0.3	0.0	0.0	0.0
300-400	0.0	-25.7	0.0	-5.0	6.9	0.0	0.0
400-500	0.0	-29.1	-6.3	-16.6	0.9	0.0	-6.3
500-600	7.2	18.2	-5.6	-11.0	-14.9	-4.8	-31.1
600-700	-2.8	16.4	-24.5	1.1	8.8	-17.3	-25.8
700-800	-18.6	6.7	-16.0	3.9	-3.0	-0.8	-8.5
800-900	-22.8	3.7	-12.5	6.6	-6.3	12.1	25.8
900-1000	-6.4	4.6	1.1	6.4	4.3	3.7	19.2
1000-1100	17.6	3.1	3.4	4.2	0.6	-3.2	12.5
1100-1200	19.5	1.9	9.8	3.9	0.6	0.5	7.6
1200-1300	4.8	0.6	7.2	2.6	0.0	0.1	3.7
1300-1500	1.4	0.2	11.8	2.5	0.0	0.0	2.8
1500-2000	0.1	0.0	21.5	1.1	0.0	0.0	0.2
>2000	0.0	0.0	9.6	0.3	0.0	0.0	0.0
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585

Maximum temperature of the warmest month

Table 101. Maximum temperature difference table between ICARDA and DAD-IS layers for the sheep areas in Turkey (1)

Sheep breeds	Akkara-man (com-mon)	Akkara-man (Kangal)	Akkara man (Kara-kaş)	Akka-raman (Nordu z)	Ama-sya Herik	Anato-lian Merino	Awassi	Dagliç	Gökçe-ada	Güney Kara-man
Class (°C)	(%)									
17.5 - 20	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0
20 - 22.5	0.2	0.0	3.2	6.7	0.0	0.0	0.0	0.1	0.0	0.3
22.5 - 25	0.0	1.4	7.0	28.7	3.7	0.8	0.0	1.3	0.0	-1.6
25 - 27.5	-5.2	-19.1	-19.6	-55.0	6.7	-3.1	0.8	3.4	1.3	1.7
27.5 - 30	5.0	17.1	1.9	18.4	-10.5	11.1	0.2	-0.2	-5.5	-1.7
30 - 32.5	-2.6	0.6	1.4	0.6	0.0	-8.9	-4.1	-3.5	4.2	4.1
32.5 - 35	-0.3	0.0	-0.9	0.0	0.0	0.0	6.4	-1.0	0.0	-2.7
35 - 37.5	1.2	0.0	1.6	0.0	0.0	0.0	0.2	0.0	0.0	0.0
37.5 - 40	1.8	0.0	5.1	0.0	0.0	0.0	-3.1	0.0	0.0	0.0
40 - 42.5	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	0.0	0.0	0.0
Total breed area (km2)	382,541	20,713	12,417	3,206	4,114	45,264	72,853	71,878	5,562	15,823

Table 102. Maximum temperature difference table between ICARDA and DAD-IS layers for the sheep areas in Turkey (2)

Sheep breeds	Hemşin	Herik	Karaca-bey Merino	Kara-yaka	Kivirçik	Morka-raman	Öde-miş	Sakiz	Tahiro-va	Tuj
Class (°C)	(%)									
12.5 - 15	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15 - 17.5	3.3	0.0	0.0	0.1	0.0	0.3	0.0	0.0	0.0	3.4
17.5 - 20	13.7	0.0	0.0	1.6	0.0	1.3	0.0	0.0	0.0	9.2
20 - 22.5	2.9	0.0	-0.8	4.2	-0.2	5.7	0.0	0.0	0.0	18.8
22.5 - 25	-8.6	0.0	0.5	-6.0	-0.3	1.2	0.0	0.1	0.2	-33.9
25 - 27.5	-13.8	0.0	0.0	-4.7	-6.0	-7.4	0.1	-0.5	-0.4	-1.1
27.5 - 30	2.5	2.1	-6.8	4.7	7.4	-5.3	11.1	-1.8	-8.9	1.8
30 - 32.5	0.0	3.7	7.2	0.0	-0.8	3.3	9.5	-2.1	5.4	1.6
32.5 - 35	0.0	-0.6	0.0	0.0	-0.2	-0.4	-20.7	4.3	3.7	0.2
35 - 37.5	0.0	2.1	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0
37.5 - 40	0.0	-8.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40 - 42.5	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total breed area (km2)	8,738	8,537	24,212	44,198	95,115	160,167	2,198	33,141	21,865	9860

Table 103. Maximum temperature difference table between ICARDA and DAD-IS layers for the goat areas in Turkey

Goat breeds	Angora (eastern)	Angora (western)	Gürçü	Hair (Kil) Goat	Kilis	Maltese	Norduz
Class (°C)	(%)						
15 - 17.5	0.0	0.0	3.3	0.1	0.0	0.0	0.0
17.5 - 20	0.0	0.0	13.7	0.7	0.0	0.0	0.7
20 - 22.5	1.0	-0.3	13.1	1.7	0.0	0.0	7.0
22.5 - 25	0.0	-0.2	-25.6	0.1	-0.5	0.0	20.1
25 - 27.5	-3.1	-1.9	-5.6	-4.5	1.2	-13.6	-51.5
27.5 - 30	-0.7	7.3	1.1	2.0	0.0	11.3	21.1
30 - 32.5	4.6	-4.8	0.0	-0.1	-5.9	-2.3	2.3
32.5 - 35	2.8	0.0	0.0	-0.2	14.0	4.6	0.3
35 - 37.5	-0.5	0.0	0.0	0.7	-2.2	0.0	0.0
37.5 - 40	-4.0	0.0	0.0	-0.4	-6.6	0.0	0.0
Total breed area (km2)	15,694	205,028	19,893	688,297	31,170	17,745	4,585