

## 4.5. Agroclimatic patterns

### 4.5.1. Agroclimatic zones

Climatic diversity in the Arabian Peninsula can be adequately represented by a simple system of agroclimatic zones that takes into account the key determinants of climate: moisture and temperature. UNESCO (1979) has developed a simple system for differentiating agroclimatic zones based on three major criteria:

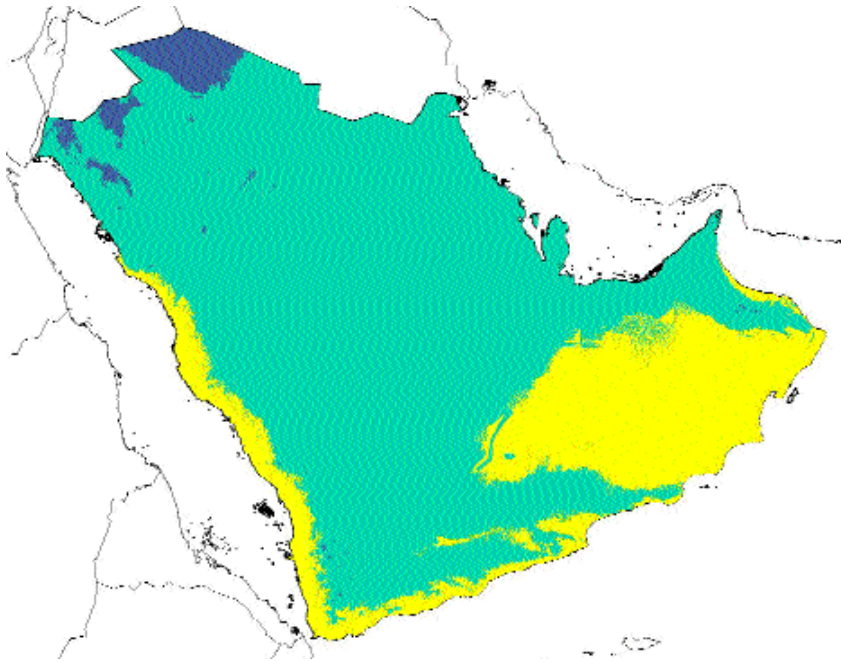
- Moisture regime
- Winter type
- Summer type

The *moisture regime* is determined by the aridity index, as defined in section 4.4.2. In the *hyper-arid* moisture regime there is almost no perennial vegetation, with the exception of some bushes in riverbeds. In good years, annual plants can grow, but agriculture and grazing are generally impossible (UNESCO, 1979). In the *arid* moisture regime, scattered vegetation does grow, which might include bushes, and small woody, succulent, thorny, or leafless shrubs. Very light pastoral use is possible. Rainfed agriculture is only feasible with some form of water harvesting and irrigation, and only where terrain conditions are favorable or where there are local water resources. As a result, agriculture, if any, is patchy. In the *semi-arid* moisture regime, vegetation is denser and might include bushes, scrubs and even trees. Good grazing areas might be found and rainfed agriculture is possible, albeit with great yield fluctuations due to rainfall variability. Agriculture in either the arid or hyper-arid classes requires irrigation (see section on land use). Even in the semi-arid mountainous uplands of Yemen, agriculture is stabilized by terrace-based supplemental irrigation.

The *winter type* is determined by the average mean temperature during the winter months. Table 4 shows the winter type classes and the areas they occupy. Figure 20 shows the spatial distribution of the winter types.

**Table 4. Areas under different winter types**

Winter type	Temperature class (°C)	%	km <sup>2</sup>
Cool (C)	<10	2.81	89,622
Mild (M)	10-20	74.71	2,379,883
Warm (W)	20-30	22.48	716,005



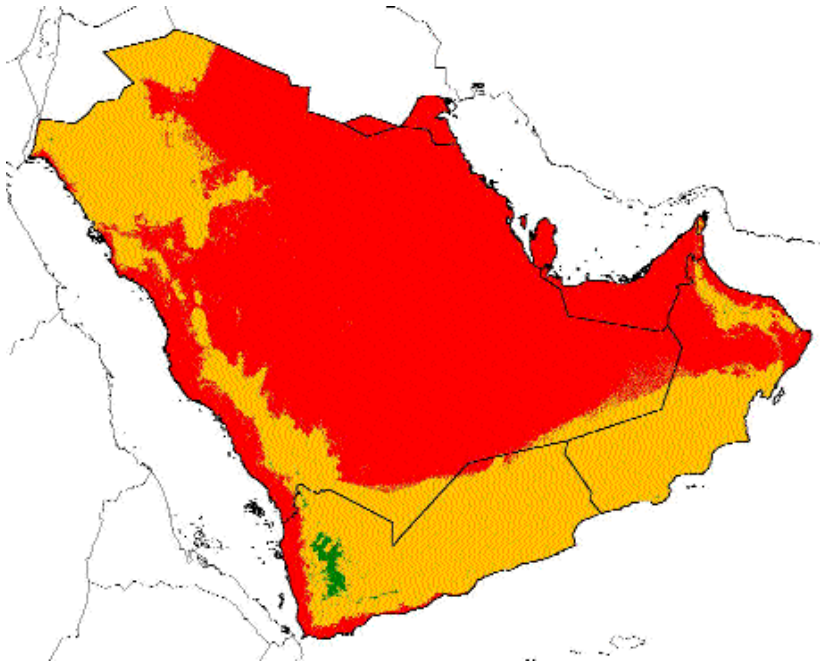
**Fig. 20: Winter types (blue: cool; green: mild; yellow: warm)**

In areas with *cool* winters, vegetation growth is limited by cold. If rainfall is concentrated in winter, plants adapted to these conditions will be characterized by rapid phenological development in spring and efficient soil moisture extraction. In areas with *mild* and *warm* winters, vegetative growth is possible in winter, and becomes more rapid with increasing temperature.

The *summer type* is determined by the average mean temperature during summer months. Table 5 shows the summer type classes and the areas they occupy. Figure 21 shows the spatial distribution of the summer types. The *mild* summers are confined to the highest parts of the Yemen highlands.

**Table 5. Areas under different summer types**

Summer type	Temperature class (°C)	%	km <sup>2</sup>
Mild (M)	10-20	0.48	15,417
Warm (W)	20-30	36.12	1,150,600
Very warm (VW)	>30	63.40	2,019,492



*Fig. 21: Summer types (green: mild; yellow: warm; red: very warm)*

The combinations between moisture regimes and winter and summer types form individual climatic patterns, or *agroclimatic zones*. For example, the pattern HA-M-VW represents a climate with a hyper-arid moisture regime, mild winter type, and very warm summer type. In total, 22 agroclimatic zones have been differentiated in the Arabian Peninsula. Of these, eight taken together comprise 95% of the region. The remaining 14 are fairly small agroclimatic ‘islands’ with climatic conditions that are either more humid or colder than surrounding areas.

The extent of the agroclimatic zones is shown, in order of importance, in Table 6. The spatial distribution is shown in Figure 22.

Figures 23a-23h are climate diagrams of stations representing some agroclimatic zones. Some zones cannot be represented due to their limited extent and the lack of meteorological data (see further).

#### **4.5.2. Similarity of climatic conditions**

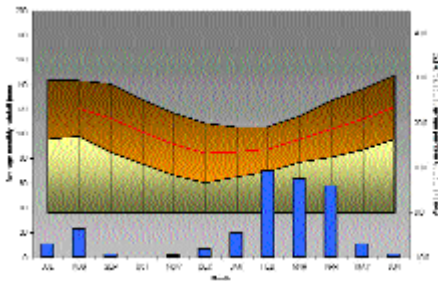
In all the maps in this chapter, the value of selected climatic parameters is shown as classes with well-defined ranges, e.g., precipitation classes 0-10 mm, 10-20 mm, etc. These classes show similarity in a way that is independent of



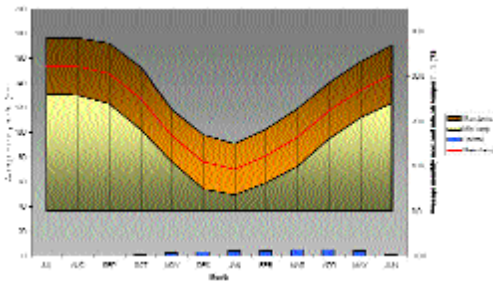
**Table 6. Extent of agroclimatic zones of the Arabian Peninsula**

ACZ	Representative station	%	Km <sup>2</sup>	ACZ <sup>1</sup>	%	km <sup>2</sup>
A-M-VW	Riyadh	35.3	1,123,841	SA-M-M	0.4	11,522
A-M-W	Abha	17.7	563,774	SA-W-W	0.1	3,481
HA-M-VW	Al Jouf	15.5	495,144	A-M-M	0.1	1,925
HA-W-VW	Muscat	7.2	229,484	SA-C-M	0.0	866
A-W-W		6.0	190,051	SH-M-M	0.0	828
HA-M-W	Tabuk	5.0	160,135	HA-C-VW	0.0	663
A-W-VW	El Kod	5.0	158,775	HA-C-W	0.0	469
HA-W-W		4.2	134,213	SA-C-W	0.0	426
A-C-W		2.4	75,341	SH-M-W	0.0	222
SA-M-W	Taiz	0.7	22,492	SH-C-M	0.0	148
A-C-VW		0.4	11,580	A-C-M	0.0	127

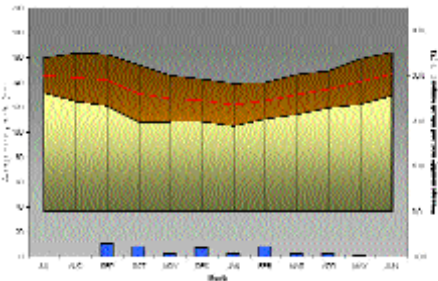
<sup>1</sup> All data from mabar station.



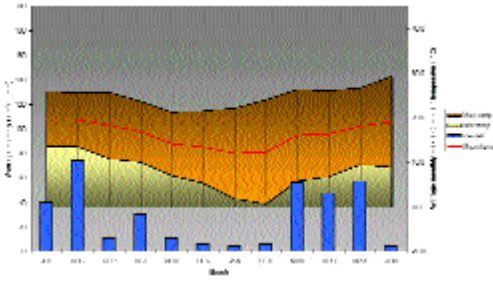
*Fig. 23a: Station representative for agroclimatic zone A-M-W: Abha, Saudi Arabia*



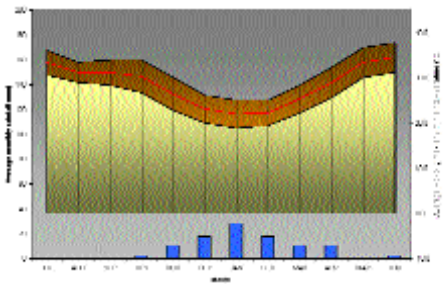
*Fig. 23b: Station representative for agroclimatic zone HA-M-VW: Al Jouf, Saudi Arabia*



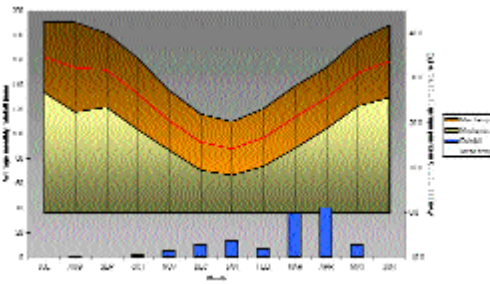
*Fig. 23c: Station representative for agroclimatic zone A-W-VW: El Kod, Yemen*



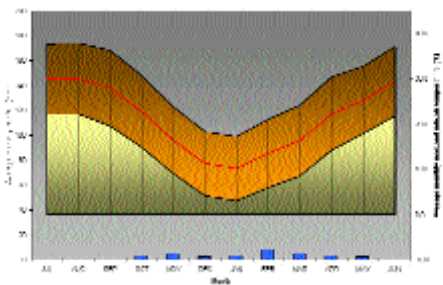
*Fig. 23d: Station representative for agroclimatic zone SA-M-M: Mabar, Yemen*



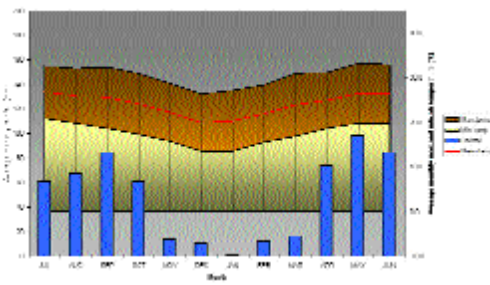
**Fig. 23e: Station representative for agroclimatic zone HA-W-VW: Muscat, Oman**



**Fig. 23f: Station representative for agroclimatic zone A-M-VW: Riyadh, Saudi Arabia**



**Fig. 23g: Station representative for agroclimatic zone HA-M-W: Tabuk, Saudi Arabia**



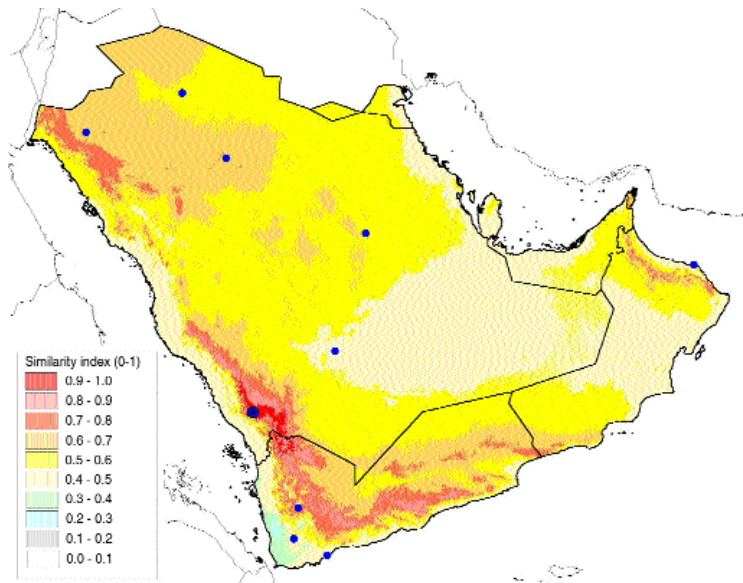
**Fig. 23h: Station representative for agroclimatic zone SA-M-W: Taiz, Yemen**

the values in individual locations. There is, however, a very different approach that consists of taking the value of a climatic parameter or index at one location (the ‘match’ location) and mapping similar locations (‘target’ locations). This approach is valuable for assessing the likelihood of successful introduction of a plant species in a different area, in the assumption that the more similar the environments the more likely will be the adaptation.

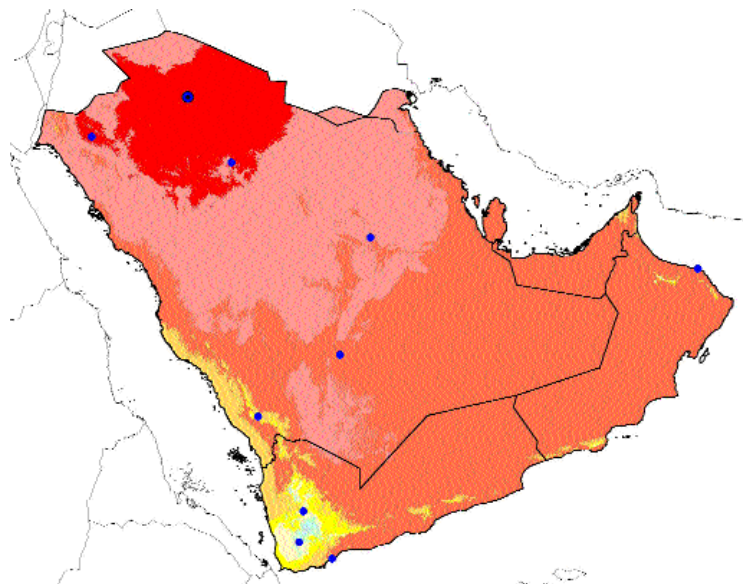
The key is to be clear in the purpose and define similarity indices accordingly. If the purpose is to assess adaptation to heat stress, a temperature-based similarity index is needed. If the objective is to assess adaptation to drought, a precipitation-based index is needed. In this publication the purpose is to assess similarity both in moisture and temperature conditions, and for this reason a combined similarity index has been developed (see Section 8.3.).

Figures 24a-24h show similarity between each part of the Arabian Peninsula and a reference location. In this case the reference locations are the stations that represent the main agroclimatic zones. In all cases, similarity is shown on the same scale between zero and one, with zero indicating total

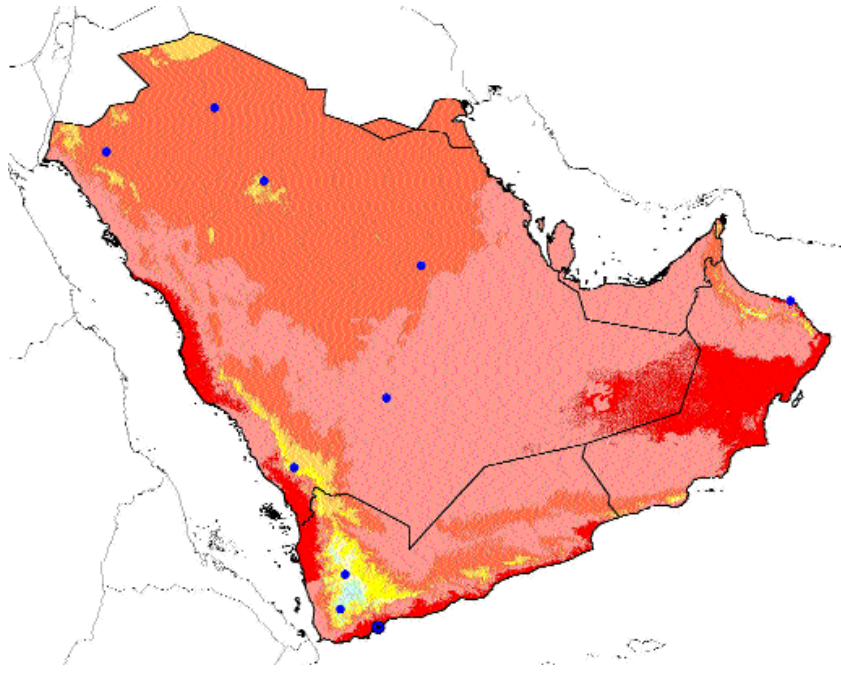
dissimilarity and one total similarity. These examples demonstrate that in some cases the adaptability domain, as expressed by a high similarity index value, is very widespread, and in other cases very limited.



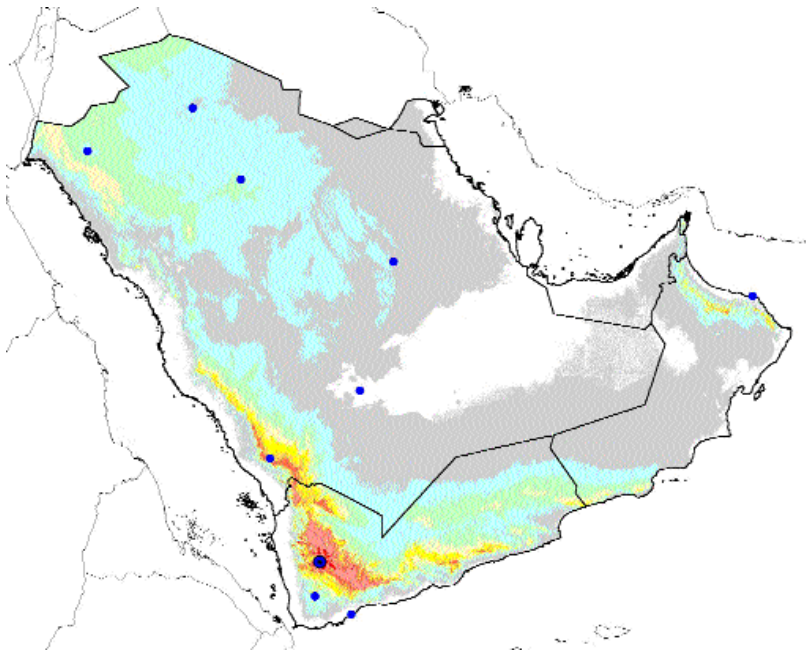
*Fig. 24a: Similarity in temperature and precipitation patterns with Abha, Saudi Arabia*



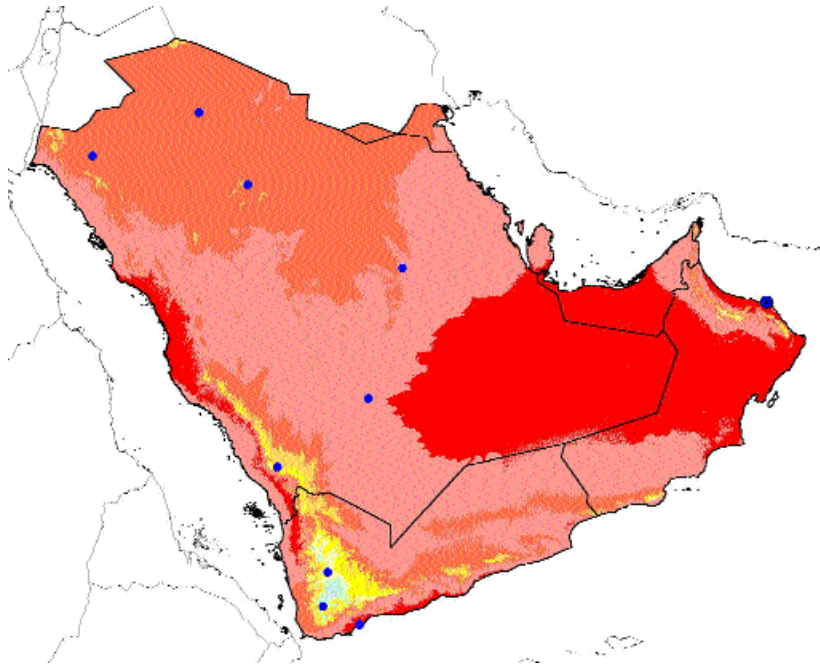
*Fig. 24b: Similarity in temperature and precipitation patterns with Al Jouf, Saudi Arabia*



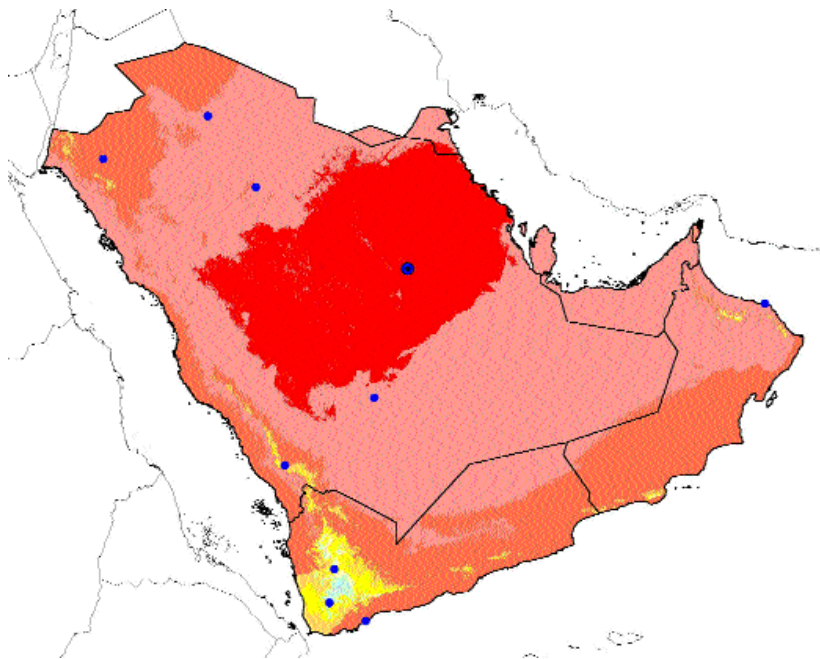
*Fig. 24c: Similarity in temperature and precipitation patterns with El Kod, Yemen*



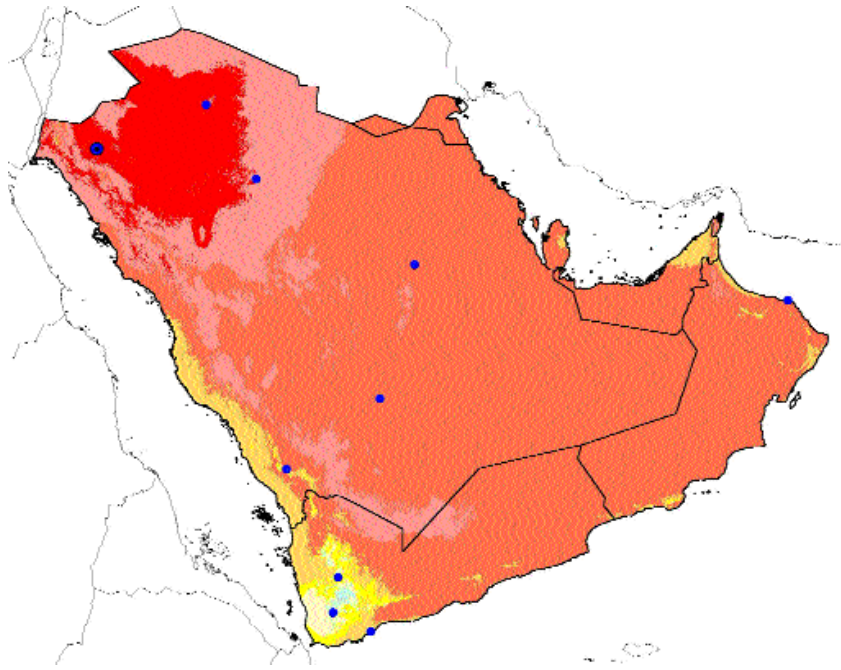
*Fig. 24d: Similarity in temperature and precipitation patterns with Maabar, Yemen*



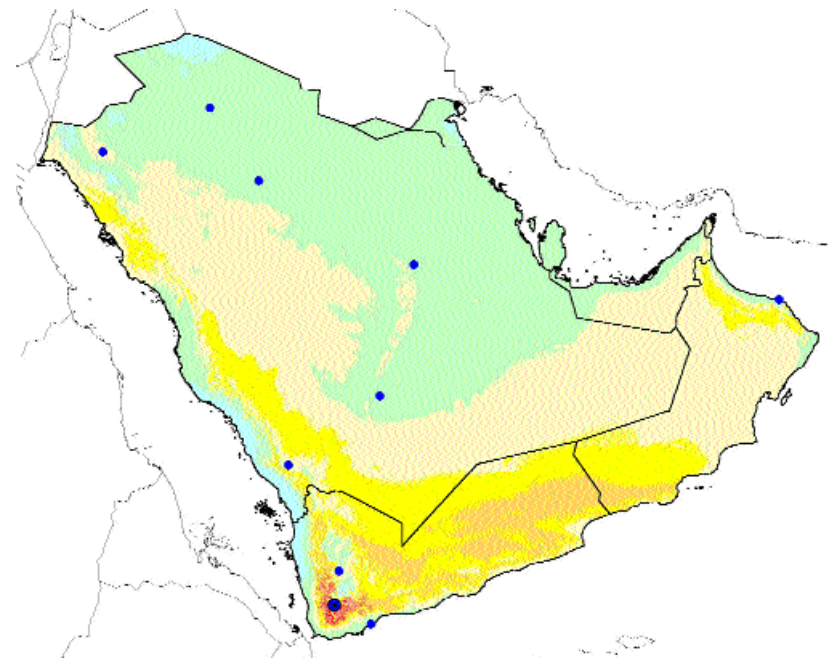
*Fig. 24e: Similarity in temperature and precipitation patterns with Muscat, Oman*



*Fig. 24f: Similarity in temperature and precipitation patterns with Riyadh, Saudi Arabia*



*Fig. 24g: Similarity in temperature and precipitation patterns with Tabuk, Saudi Arabia*



*Fig. 24h: Similarity in temperature and precipitation patterns with Taiz, Yemen*