4.7. Biomass productivity and climate

Climate is the primary determinant of potential biomass productivity of plants and crops. This is because assimilation – the capture by plants of carbon dioxide from the atmosphere and its conversion into carbohydrates – is determined by radiation energy and water availability. Biomass productivity should, therefore, be related to climatic factors, in particular temperature (as proxy for the radiation energy) and soil moisture. Apart from radiation and moisture regime,

the rate of assimilation and biomass production is strongly determined by crop characteristics.

According to the response of assimilation rate to temperature, FAO (1978-81) has proposed four crop groups (Table 7). Each crop group has a different response function, or adaptability range, to temperature (Figure 28).

Table 7. Adaptability ranges of different crop groups

Crop group	Crop types	Optimal mean temperature range	Examples
1	C3	15-20	Barley, bread wheat, chickpea, lentil, olive, sunflower, cabbage, oats, rye, grape, sugar beet; temperate grasses; almost all trees
2	C3 adapted for higher temperatures	25-30	Cotton, groundnut, cowpea, soybean, tobacco, sunflower, sesame, rice, fig, grape, olive
3	C4	30-35	Maize, sorghum, sugarcane, all millets, fonio rice; tropical grasses
4	C4 adapted for lower temperatures	20-30	Maize, sorghum, millets

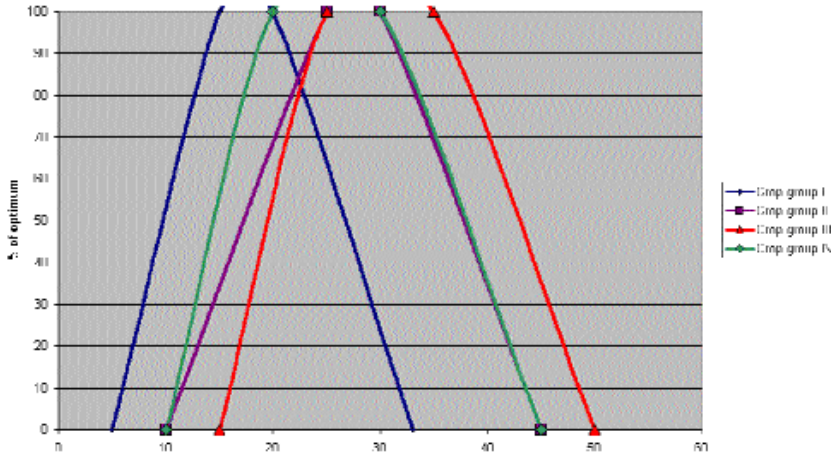

Fig. 28: Temperature adaptability ranges for different crop groups

Using this concept of crop adaptability groups, biomass productivity indices have been developed for each crop group. For the exact definition of each crop biomass productivity index (CBPI) refer to Section 8.3.

The biomass productivity index was calculated for each crop group (CBPI1, CBPI2, etc.) for each location in the Arabian Peninsula. The results show that only in part of the Yemen highlands do the indices have non-zero values. This is not surprising because the CBPI is strongly correlated with growing period, which is absent in most of the Peninsula.

Figures 29a-29d focus on the Yemen highlands and show the values of the CBPI for each crop group. Generally speaking, these figures show that the areas are better adapted to crop groups 2, 3, and 4 than to crop Group 1.

To assess the potential productivity of rangelands, a different kind of index is required that is less demanding in terms of moisture regime. The rangeland biomass productivity index (RBPI) is the product of the aridity index (see Section 4.4.2.) and the annual accumulated heat units (see Section 8.3.). Distribution of the RBPI is shown in Figure 30.

The value of these biomass productivity indices is that they can be derived from simple climatic data and allow extrapolation from site-specific productivity measurements. It has to be realized that they provide a measure of *potential* productivity, not current productivity, and, therefore, do not take into account management factors, such as overgrazing, etc.

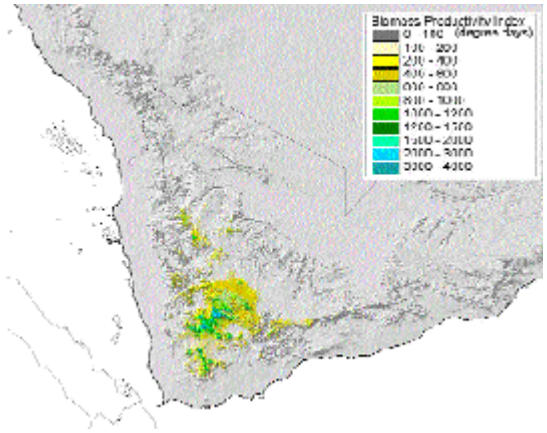

Fig. 29a: Biomass productivity index for crop group I, Yemen Highlands

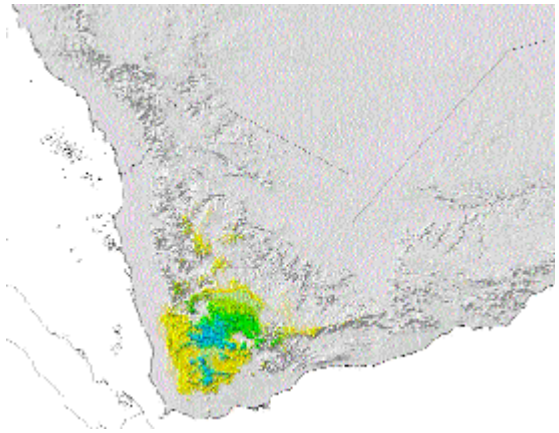

Fig. 29b: Biomass productivity index for crop group II, Yemen Highlands

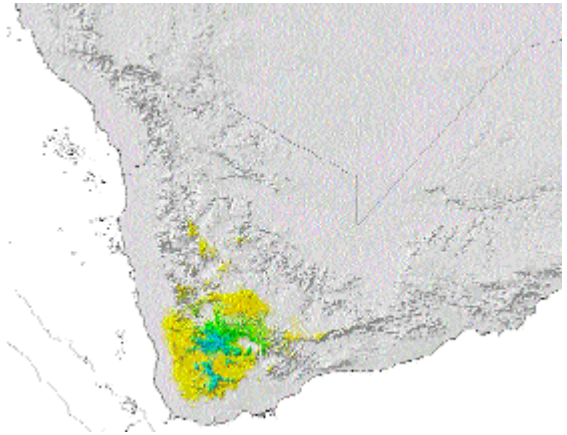

Fig. 29c: Biomass productivity index for crop group III, Yemen Highlands

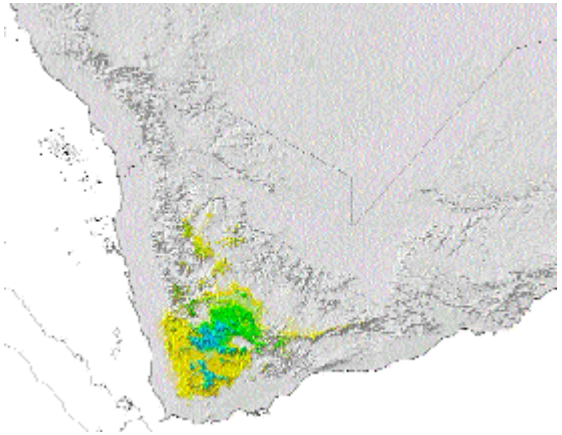

Fig. 29d: Biomass productivity index for crop group IV, Yemen Highlands

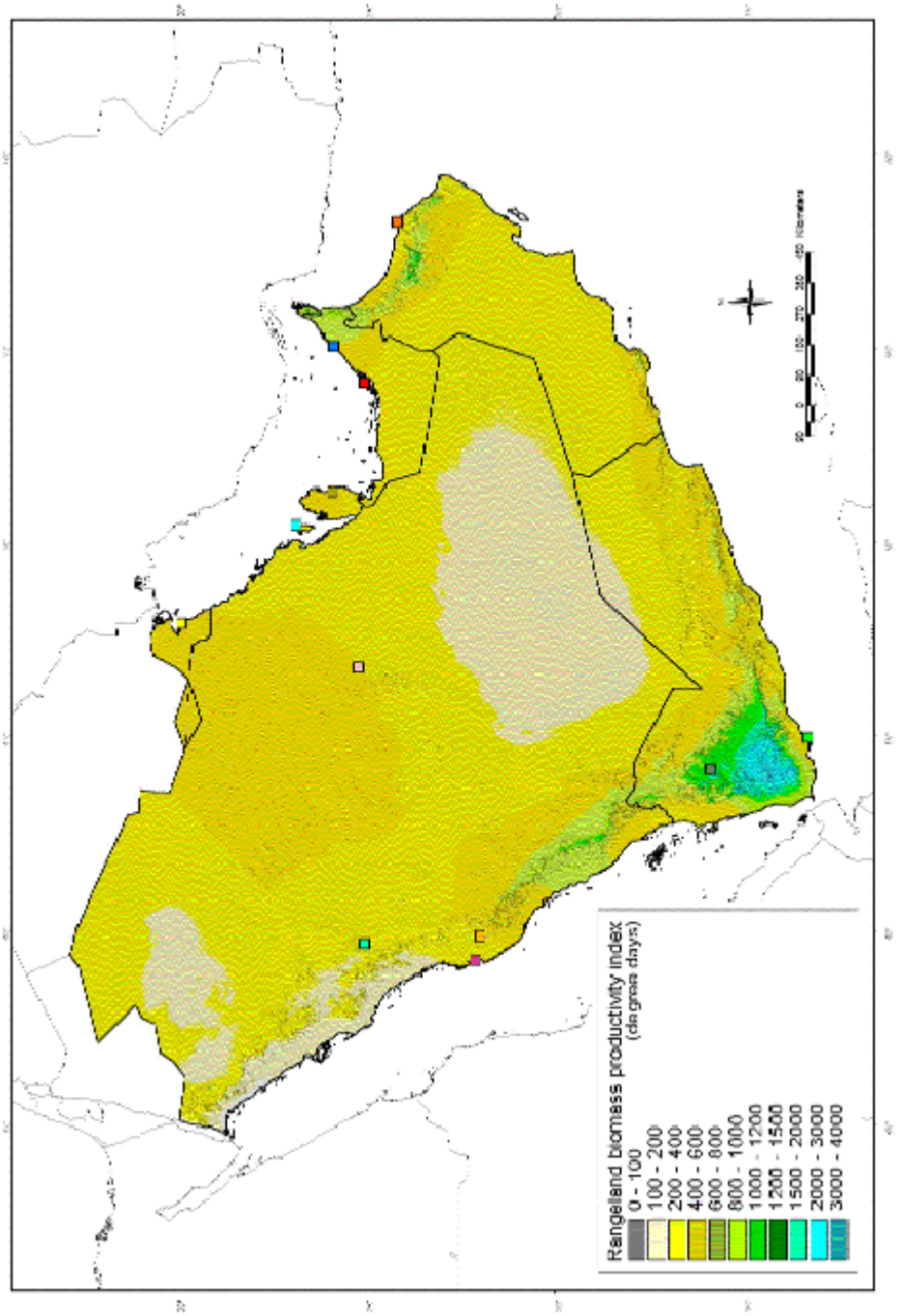

Fig. 30: Rangeland biomass productivity index