11. CONCLUSION

The combination of a phytosociological description of vegetation, coupled with a supervised classification of satellite data proved relatively successful in this study. Limitations of the data to fully delineate all associations and vegetation types described can be based on the study design and delineation of the study area. BIOTA up to date focussed strictly on the vegetation of plains as the project overall looks at major environmental gradients spanning over several biomes (refer back to Figure 1). There is thus a contradiction in scale in the study design: the transect layout may be sufficient to get an overview of vegetation on a larger (e.g. biome) scale. For the aims of the Namibian Vegetation Map, however, the placement of the transect proved to be limiting. The main reasons are that the transect only bordered several pre-delineated vegetation types, thus only "outliers" of these were sampled; also, mountains should have been included, even though it can be expected that mountain flora will vary from one inselberg to the next. These shortcomings should not be seen as strictly negative, however - one of the aims of BIOTA Phase I (which is regarded as a preliminary phase) is not only to gather baseline data, but also to verify study design. The initial maps obtained from this study will form the "baseline data" from which the extend of various vegetation units within central Namibia may be extrapolated and verified with comparably little additional effort.

This study also showed that when considering the use of satellite imagery for vegetation mapping, the process of field sampling and classification of satellite data should be considered an iterative process, until an acceptable result is achieved. The classification of vegetation shown on maps 5 and 6 (Appendix 4) should be seen as a first interim result. It has become very clear that areas, where the satellite images overlap should be identified in advance and sampled more intensely to allow for a more accurate merging of different satellite scenes where one continuous vegetation map is desired as a result. However, the satellite classification also clearly showed where more samples are required, which will enable more efficiently targeted fieldwork for follow-up surveying of vegetation. As experienced in this study, initial survey-stratification should be rather based on false-colour satellite maps than on a-priori unsupervised satellite classification. In the case of this study it would have been too much of a generalisation, which would have led to under-sampling of the vegetation and a poor description of vegetation types.

The vegetation description and preliminary delineation with satellite data showed relatively good similarities with veld types described in the Homogenous Farming Areas Report. In the southern region of the study area, the Okahandja Thornbush Savanna (unit A6 of the Homogenous Farming Areas Report) can be further subdivided into *Acacia mellifera - Monechma genistifolium* low semi-open bushland (association 5), Albizia *anthelmintica - Stipagrostis uniplumis* low open woodland (association 6), Acacia *mellifera - Aristida congesta* low semi-open bushland (association 7) and *Boscia foetida - Leucosphaera bainesii* low semi-open bushland (association 10).

In the central-eastern parts of the study area, the Osire Sandveld (unit A5 of the Homogenous Farming Areas Report) can be described in terms of the *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland (association 8), with inclusions of the *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland (association 9).

These veld types also merge into the Erosion Areas of the Etjo Catchment Area (unit C A6 of the Homogenous Farming Areas Report). These erosion areas can be subdivided into *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland (association 1), Boscia *albitrunca - Eragrostis cylindriflora* low open woodland (association 2) and Acacia *mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland (association 3).

To the north, the Etjo Catchment Area merges into the Otjiwarongo Thornbush Savanna (unit A4 of the Homogenous Farming Areas Report), which can be subdivided into *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland (association 9) and *Terminalia prunioides - Croton gratissimus* low closed bushland (association 14).

The northern region of the study area mainly resembles the Otjenga Plains (unit A3 of the Homogenous Farming Areas Report), which can be subdivided into *Acacia mellifera - Stipagrostis hirtigluma* low moderately closed bushland (association 11), Acacia *mellifera - Cenchrus ciliaris* low moderately closed bushland (association 12) and Dichrostachys *cinerea - Cenchrus ciliaris* low moderately closed bushland (association 13).

Although the Namibian Maize Triangle (unit A9 of the Homogenous Farming Areas Report) is indicated as covering the north-eastern tip of the study area and has some

resemblance to *Terminalia prunioides - Croton gratissimus* low closed bushland (association 14), it is felt that this part of the study area should rather be included in the Otjenga plains with its different vegetation types. Mountainous vegetation bordering this area should be surveyed in more detail and reclassified.

A formal delineation and description of major vegetation types for the study area will only be feasible by an extension of the study area to vegetation types identified by the study, but so far only marginally covered.

Within the study area, environmental variables most strongly influencing the distribution of vegetation are soil texture and -type, rainfall gradients as well as underlying geology.

Acacia mellifera - Eragrostis rotifer low moderately closed bushland (association 4) is not part of any specific vegetation type, but is distributed especially along all riverine systems.

From a management point of view, *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland (association 1), *Boscia albitrunca - Eragrostis cylindriflora* low open woodland (association 2) and *Acacia mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland (association 3) have a relatively low value as farming (grazing) lands. Under prevailing environmental conditions, grass cover is generally low and the dominant grasses present have little leaf mass or low grazing values (Müller 1985, Van Oudtshoorn 1999).

The *Acacia mellifera - Monechma genistifolium* low semi-open bushland (association 5), Albizia *anthelmintica - Stipagrostis uniplumis* low open woodland (association 6) and Acacia *mellifera - Aristida congesta* low semi-open bushland (association 7) form the basis of farming practices especially south of the Omatako Mountains. *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland , although very localised, appears to be more resilient to over-utilisation (due to possibly a more favourable soil-moisture regime), which is apparent in associations 5 and 7. All three vegetation types can be regarded prone to bush encroachment (especially by *Acacia mellifera*) as a result of degradation. *Boscia foetida - Leucosphaera bainesii* low semi-open bushland (association 10) occurs sporadically throughout these vegetation types and is, based on its calcrete soils, prone to degradation.

Acacia erioloba - Stipagrostis uniplumis low semi-open bushland (association 8) and *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland (association 9) are the basis of farming practices especially in the central regions of the study area. Although the former vegetation types is still in relatively good condition, it is equally prone to an increasing establishment of hard, unpalatable grasses as the latter vegetation type as a result of degradation. Degradation is more widespread in the *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland, which many farmers attribute to past very high stocking rates. It is also severely affected by bush-encroachment of especially *Acacia mellifera* and *Dichrostachys cinerea*.

Acacia mellifera - Stipagrostis hirtigluma low moderately closed bushland (association 11) *Acacia mellifera - Cenchrus ciliaris* low moderately closed bushland (association 12) and *Dichrostachys cinerea - Cenchrus ciliaris* low moderately closed bushland (association 13) are the basis of farming resources in the northern regions of the study area. All three vegetation types are susceptible to high degrees of bush encroachment, but associations 11 and 13 are especially prone to degradation due to their shallow soils.

Terminalia prunioides - Croton gratissimus low closed bushland (association 14) occupies more rocky habitats and has a naturally weak herb- and grass layer. This layer is easily degraded. Further, this vegetation tends to high levels of thickening of shrubby vegetation, especially by *Terminalia prunioides*. This vegetation thus has a low value as a farming resource.

Overall, veld types recorded in the study area will benefit from more conservative and/or carefully planned management practices to avoid over-utilisation of resources and resultant, usually irreversible degradation. Restoration practices of degraded rangelands may be possible, but will often require an initial drastic reduction (not total removal) of the invading shrubs, which is an expensive process.