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ASSESSMENT OF THE STATUS AND TRENDS AND OPTIONS FOR CONSERVATION AND SUSTAINABLE USE OF TERRESTRIAL BIOLOGICAL DIVERSITY: DRYLAND, MEDITERRANEAN, ARID, SEMI-ARID, GRASSLAND AND SAVANNAH ECOSYSTEMS

Note by the Executive Secretary

1. INTRODUCTION

1. The need to examine the issue of biological diversity of dryland ecosystems was initially raised by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), at its second meeting. In fact, SBSTTA recommendation II/1, paragraph 22(ii) considered the: "Preparation of thematic assessments of knowledge and status of biological diversity on one or more of the following ecosystems: arid and semi-arid land; grasslands…". In addition, in its recommendation II/7, paragraph 20, SBSTTA also addressed the "expansion of agriculture to frontier areas, including forests, savannah, wetlands, mountains and arid lands". Finally, in its recommendation II/8, SBSTTA recommended "the Conference of the Parties to ask the Executive Secretary to explore ways and means to cooperate with the United Nations Convention to Combat Desertification on matters relating to biological diversity and drylands with a view to identifying common priorities for further consideration at the next meeting of the Subsidiary Body on Scientific, Technical and Technological Advice".

2. In its Decision III/13, the Conference of the Parties, at its third meeting, considered drylands, along with mountain and inland water ecosystems, as one the main items of the future programme of work for terrestrial biological diversity and endorsed paragraph 5 of recommendation II/8 of the Subsidiary Body on Scientific, Technical and Technological Advice. It requested the Executive

Secretary to explore ways and means to cooperate with the UN Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification particularly in Africa, on matters relating to biological diversity and drylands, with a view to identifying common priorities".

3. The most recent important decision regarding these ecosystems was adopted by the Conference of the Parties, at its fourth meeting. In its Decision IV/16, Annex II, the Conference of the Parties, adopting the programme of work for the period from its fourth meeting to its seventh meeting, decided that dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems are matters requiring in-depth consideration at its fifth meeting.

4. In order to assist SBSTTA, at its fourth meeting, to consider this issue, the Secretariat has prepared this note which consists of an assessment of the status and trends and options for the conservation and the sustainable use of the biological diversity of dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems.

2. I. DRYLANDS AND THEIR RELATIONSHIP WITH MEDITERRANEAN, GRASSLAND 3. AND SAVANNAH ECOSYSTEMS

5. Drylands are conventionally defined in terms of water stress, as areas where the mean annual ratio of precipitation (P) to potential evapotranspiration (PET = potential evaporation from soil plus transpiration by plants) is significantly less than one. Thus, the term 'dryland' indicates that certain broad conditions of water availability apply on average over a given part of the Earth's surface, but it is not itself a descriptor of ecosystem type or of land cover. A mutually exclusive set of dryland subcategories (hyperarid, arid, semi-arid, dry sub-humid) is distinguished on the basis of defined P/PET limits. There is no straightforward relationship between the regions and ecosystem types discussed here and other major terrestrial ecosystem types already addressed under the Convention, namely forests, inland water and agricultural ecosystems.

6. Drylands may also be defined as terrestrial areas with a ratio of mean annual precipitation to mean annual potential evapotranspiration of less than 0.65, excluding polar regions and some high mountain areas with a cold climate year-round that meet this criterion but have completely different ecological characteristics from other. UNEP (1997) estimates that some 61 million square kilometres, or just over 47 per cent of the world's land surface, are classifiable as dryland (excluding cold climate regions). However, it must be recalled that dryland boundaries are neither static nor abrupt, so that precise delimitation of dryland areas remains elusive. Of the total global area of drylands, nearly 10 million square kilometres consist of hyperarid, or true desert, regions where rainfall is extremely low, and unpredictable in space and time; in some years there is no rainfall at all. These areas have a P/PET ratio of less than 0.05 (UNEP, 1997). Nearly 70 per cent of the hyperarid zone is made up of the Sahara desert in Africa. The remaining drylands - some 51 million square kilometres - comprise arid, semi-arid and dry sub-humid areas characterised by rainfall which, except in the more arid areas, tend to be seasonal with more or less marked annual variation. These regions support about one fifth of the world's population (UNEP, 1997), and are collectively termed 'susceptible drylands' because of their vulnerability to degradation.

7. Arid areas are defined as regions where the P/PET ratio is greater than or equal to 0.05 and less than 0.20, and semi-arid areas as those where it is greater than or equal to 0.20 and less than 0.50. Arid and semi-arid areas are therefore subsets of dryland areas. Arid regions are estimated by UNEP (1997) to cover some 16 million square kilometres, more evenly distributed across the continents than hyperarid regions.

8. Mediterranean ecosystems are climatically identified as having generally cool, wet winters and warm or hot dry summers. However, no single climatic or bioclimatic definition of a Mediterranean ecosystem has yet been established, so that these areas remain somewhat loosely defined. Mediterranean ecosystems encompass a wide range of habitat types including forest, woodland and grassland, but are typified by a low, woody, fireadapted sclerophyllous shrubland (maquis, chaparral, fynbos, mallee) on relatively nutrient-poor soils. These systems occur in five distinct parts of the world: the Mediterranean basin; California (U.S.A.); central Chile; Cape Province (South Africa); and southwestern and south Australia. They cover between 1 and 2 per cent of the Earth's surface (according to the above definition). In terms of species per unit area, they appear to be disproportionately rich. More than three-quarters of the total Mediterranean-type ecosystem area are within the Mediterranean basin. In most parts of the world where they are found, a proportion of ecosystems generally classified as Mediterranean occur within dryland areas according to the definition given above.

9. Grassland ecosystems may be loosely defined as areas dominated by grasses (members of the family Gramineae excluding bamboos) or grass-like plants with few woody plants. Natural grassland ecosystems are typically characteristic of areas with three main features: periodic drought, fire, and grazing by large herbivores. In addition, they are often associated with soils of low fertility. The relative importance of different factors in maintaining grasslands varies locally and regionally.

10. Savannahs are tropical ecosystems characterized by dominance at the ground layer of grasses and grass-like plants. They form a continuum from treeless plains through open woodlands to virtually closed-canopy woodland with a grassy understorey. Some savannah areas therefore also meet the general definitions of forest, while others do not.

11. Most of the world’s natural grasslands and savannahs, but by no means all, are found in dryland regions. Around 20 per cent of the Earth's land surface (excluding Antarctica) supports grasslands of varying degrees of naturalness from those that are in pristine state to those that are influenced to a greater extent by human activity. Temperate grasslands make up approximately one fourth of this area, and savannahs the remainder. Seasonally flooded grassland areas are found in many river basins and may be of considerable ecological and biotic importance as well as economic importance for their quality pasture. Such areas may be then considered as grassland ecosystems or inland water ecosystems but there is no clear dividing line between the two.

4. II. SPECIFIC PROBLEMS AND ISSUES OF IDENTIFICATION, MONITORING AND ASSESSMENT OF DRYLAND, MEDITERRANEAN, ARID, SEMI-ARID, GRASSLAND AND SAVANNAH ECOSYSTEMS

12.Assessment of the condition of dryland vegetation is difficult, chiefly because dryland ecosystems tend to be naturally highly dynamic disequilibrium systems. Many dryland vegetation communities respond to rainfall when it occurs but otherwise display very limited or negligible productivity (UNEP, 1997). It may thus be difficult to tell whether a particular vegetation state is the result of response to adverse short-term environmental conditions (mainly drought) or is genuinely a reflection of long-term or irreversible degradation.

13. Because, under natural conditions, transitions between ecosystem types are rarely abrupt, but rather are often gradual or patchy, the dividing line between savannahs or grasslands and other ecosystems, such as forests, wetlands or semi-desert is inevitably based on more or less arbitrary measures. For example, a maximum limit of 10 to 15 trees per hectare is sometimes used to define grassland. Demarcating the limit of these ecosystem types on the ground may therefore often also seem an arbitrary exercise.

14. Natural grassland and savannah ecosystems are typical of areas with highly seasonal rainfall which often also show marked year-by-year variation. This variation may be on timescales ranging from the decadal (for example that associated with the periodic, though irregular, El Niño-Southern Oscillation (ENSO) events) to the millennial or longer. Climatic variation of this kind interacts with other factors, such as frequency of fire and population density of grazing herbivores, in a complex fashion (which is further complicated by the multiple effects of humans, as shown in more detail below), so that these ecosystems are often highly dynamic and variable through time. This variability extends both to changes in extent and to changes in state or condition, further complicating efforts to assess them.

15. Given these difficulties of demarcation and definition, it is not surprising that estimates for both the possible original (i.e. pre-human period) and present extent of grassland and savannah are highly variable. Some estimates of potential natural vegetation cover (i.e. the expected vegetation cover with no influence from humans) suggest that as much as 40 per cent of the world's land surface, equivalent to 53 million square kilometres, were grassland and savannah, although a more widely accepted figure is 25 per cent, or 33 million square kilometres. Estimates for the current extent of grasslands and savannahs range from 24 to 35 million square kilometres. This is to be compared with estimates of current world forest cover of 35 to 40 million square kilometres.

5. III. OVERVIEW OF THE SPECIES BIOLOGICAL DIVERSITY OF DRYLAND, MEDITERRANEAN, ARID, SEMI-ARID, GRASSLAND AND SAVANNAH ECOSYSTEMS

Drylands

16. Soils in dryland areas are typically poorly developed, water being the key limiting factor to growth. True desert species show a wide range of adaptation to the extreme environment. Amongst animals, groups that are intrinsically adapted to very low moisture environments include reptiles and many arthropods, although species in a wide range of other groups have also evolved to cope with these conditions. Strategies for survival amongst both plants and animals often include long periods of dormancy (as seeds, in the case of many plants) punctuated with brief periods of high activity, migrations and productivity coinciding with rare rainfall events.

17. Biological diversity, assessed in terms of species number, tends to be moderate in semi-arid areas and to decline to low or very low levels as aridity increases. In contrast to this general rule, diversity in some groups - scorpions and other predatory arthropods, tenebrionid beetles, ants, termites, snakes and lizards, annual plants - tends at first to increase as aridity increases but to decrease at the stage of extremely dry ecosystems such as true deserts. Diversity at the genetic level in dryland species has been sampled very unevenly, but is well-marked in some groups, particularly so in some desert plants where different forms of the same species may vary in karyotype or carbon metabolism. Much interest is currently focused on identifying the genetic basis for drought tolerance, salt tolerance, and other traits associated with dryland stress conditions that could eventually be utilised to improve productivity in dryland agriculture. In this connection, the bioprospection of extremophile microorganisms is a very promising approach.

Mediterranean ecosystems

18. The characteristic shrublands of Mediterranean ecosystems occur within areas exhibiting a Mediterranean climate where soil fertility is too low to support grass or trees, with significant differences in vegetation structure between regions, in part a consequence of differences in the annual distribution of rainfall. In South Africa the plant community contains an abundance of species of the heather family Ericaceous as an understorey to low broader-leafed shrubs, most typically members of the family Proteaceae.

19. Species richness in Mediterranean-type ecosystems, particularly among plants, is generally high - approaching values for moist tropical forest areas - as is endemism. Among the five Mediterranean-type ecosystems, species richness is highest on the poorer soils of South Africa and southwest Australia, and lower on the richer soils of California, Chile and the Mediterranean proper.

20. Countries around the Mediterranean basin hold some 25,000 vascular species (about 10 per cent of all vascular plants) of which around 60 per cent are endemic to the Mediterranean region. The other four Mediterranean-type ecosystem regions are widely recognised as biological diversity hotspots holding a disproportionate amount of global biological diversity in relation to their area. Of these four types, California (most of which has a Mediterranean-type climate) alone holds more than 5,000 vascular plants (30 per cent being endemic); equivalent to one fourth of the flora of the continental United States of America.

21. The characteristic vegetation in the Cape Mediterranean-type ecosystem is fynbos, a fire-prone sclerophyllous shrubland on sandy nutrient-poor soils. At fine scale, average plant species richness is moderate, i.e. around 16 species per square meter quadrate. However, diversity is compounded by the fact that many species have small ranges, and there is a uniquely high turnover in the species composition of plant communities along ecological and geographical gradients. At landscape scale, richness accordingly rises to very high values, for example, 2,256 species in 471 square kilometres on the Cape peninsula, and the entire Cape floristic region (including some non-fynbos vegetation) holds some 8,550 species, about 70 per cent of which are endemic. Levels of diversity do not necessarily correspond in other groups: for example, in the Cape Mediterranean-type ecosystem, reptile diversity is only moderate while bird and mammal diversity is relatively low.

22. In contrast to other Mediterranean-type ecosystem regions, the Mediterranean basin has for many centuries been subject to intense human activities, including forest clearance and grazing, so that little natural vegetation remains. It has been suggested that the plant diversity is locally high because of the number of species that have evolved as components of successional vegetation in response to frequent disturbance. However, heathland in Australia appears to be a natural formation.

Grasslands and Savannahs

23. Grasslands in general are found where annual precipitation is too low to support forest, and where early season rainfall allows high productivity of vegetation and biological resources. Key selection pressures are grazing pressure and the effects of fire. Grazing tends to increase abundance of less palatable species and to increase species richness in productive areas, or decrease it in less productive areas. Modest frequency of fires tends to increase diversity, while annual fires favour grasses and rare fires favour woody species. These pressures have important impacts on vegetation structure in grassland and savannah systems. Firstly, a high proportion of plant biomass (made of roots and rhizomes) and metabolic activity is located underground; secondly, there is a high turnover of those parts of the plant above ground; thirdly, the persistent or perennating parts of the plant are generally located near the soil level.

24. One important consequence of this is that grassland soils, especially in more humid environments, are often rich in organic matter and are thus vulnerable to conversion to cropland, with replacement of native grasses by their domestic derivatives (cereals) and other plants.

25. At very fine spatial scales natural grasslands can be among the most species-rich habitats on Earth. For example, up to 80 plant species have been identified in a single square meter quadrate in the Central Asian steppe, or 42

plant species in one 0.25 square meter quadrate in pine savannah on the United States Atlantic coastal plain. Nevertheless, plant communities tend to be similar over large areas, and structurally simple, so that at the landscape scale diversity is relatively low compared with tropical moist forest or Mediterranean-type ecosystems.

26. The world's grasslands and savannahs host very distinctive plant and animal communities, while diversity tends to increase towards the tropics. All these systems hold an array of native herbivores, and these in turn support a number of high profile mammalian and avian predators. The savannah communities of East Africa are typified by large herds of ungulate herbivores, including a remarkable diversity - more than 70 species - of antelopes and other medium- to large-sized bovids. In this region, the biomass of ungulate herbivores is the highest recorded in any terrestrial environment. This biomass is founded on the relatively high productivity of savannahs; with temperate grasslands and tundra, they have the highest ratio of plant productivity to plant biomass of any terrestrial ecosystem.

27. Although diversity at species level is not high in most grassland and savannah systems, considerable genetic diversity (shown, for example, in pest or drought resistance) has been recorded where relevant investigations have been made.

6. IV. MAJOR IMPACTS ON THE BIOLOGICAL DIVERSITY OF DRYLAND, MEDITERRANEAN, ARID, SEMI-ARID, GRASSLAND AND SAVANNAH ECOSYSTEMS

28. Humans have had enormous impacts on dryland ecosystems, particularly on grassland and Mediterranean ecosystems, often with major negative impacts on biological diversity. These impacts are often complex and interrelated. The following categories of activities are among the major ones that have or can have an adverse impact:

Ecosystem conversion

29. Complete transformation of natural ecosystems is the most extreme form of human impact. In the ecosystems under discussion, the most extensive form of transformation is conversion to cropland. However, in dryland areas, most crops require irrigation, so that such largescale transformation to cropland is only possible when freshwater is available, either as surface water (lakes, rivers, reservoirs) or in aquifers.

30. This imposes limitations on the global area susceptible to conversion. In many dryland areas, conversion is followed by abandonment as soil becomes degraded, often through soil erosion, severe soil fertility decline, salinisation or waterlogging (the last two through excessive application of water). Extensive livestock raising and strong management is important in dryland areas, especially where livestock transhumant systems have been developed by local herders to cope with limited water or storage capacities. In grassland and Mediterranean ecosystem areas outside dryland regions, lack of water is less of a problem. In consequence a very large proportion of such areas has been converted to crops of various kinds (including orchards and timber plantations). Conversion for other purposes (building, road-construction, mines, dams), while at a lesser scale overall, may be locally of great importance. Of particular note is loss of natural habitat to building land in coastal zones, especially in Mediterranean-type ecosystems

Grazing by introduced herbivores

31. Domestic livestock grazing is the most extensive human use of grassland ecosystems in most arid or semi-arid ecosystems. Livestock have an impact on ecosystems through trampling, removal of plant biomass, alteration of plant species composition through selective grazing and competition with native species. The impact of this practice on the biological diversity of these ecosystems has been variable.

32. In some areas where the native vegetation is well adapted as a result of evolution, the impact on plant species diversity has been relatively small. In other areas, where vegetation has not evolved in the presence of hooved herbivores, the changes have been very large. Sometimes, particularly in tropical and semi-tropical grasslands, there has been a shift from grass-dominated vegetation to one dominated by woody plants. In almost all cases wild animal diversity has been greatly affected (mostly through competition and hunting, but also through spread of pathogens), so that the biomass of domestic livestock greatly exceeds that of native wild herbivores. In some areas, feral species, such as rabbits, hares, camels, donkeys, horses or goats, may also have a very marked impact on natural or semi-natural ecosystems.

Introduction of alien plant species

33. Grassland ecosystems have been routinely modified by deliberate introduction of non-native plant species, particularly other grasses and leguminous plants, to increase grazing quality and productivity, by increasing fixation of atmospheric nitrogen. Initially, this may result in an apparent increase in plant species diversity but, at the same time, a decrease in ecosystem diversity could follow.

Such an apparent increase in species diversity generally reverses as the introduced species displace the native ones.

34. There is evidence that in the long run increases in productivity may also be reversed. In addition, lower diversity and modified grassland ecosystems appear to be less resistant to environmental perturbation, particularly drought.

Changes in fire regimes

35. One of the commonest extensive forms of management in pastoral systems is the use of regular burning in order to encourage new growth for livestock to feed on. Many dryland, Mediterranean-type, grassland, savannah and ecosystems are naturally adapted to some degree to fire. However, in the absence of anthropogenic disturbance, such fire is almost invariably the result of dry electric storms, which are often of infrequent occurrence. The far higher frequency of anthropogenic burning usually has a very different impact on ecosystems and their biological diversity. In general, frequent burning favours grasslands while infrequent burning favours woodier habitats and ecosystems. It should be mentioned that this issue is very complex and has been the subject of substantial research that cannot be adequately reflected in the current paper.

Water

36. By nature, water is a limiting factor in dryland ecosystems. Human use of existing water resources in these systems therefore has often a disproportionately extreme impact. Abstraction of water for irrigation from freshwater systems such as lakes and rivers has an often extreme impact on the biological diversity of these ecosystems. Depletion of groundwater resources may have a less obvious direct impact, especially in the short term, but is likely to affect natural ground-fed springs and deep-rooted vegetation where the aquifer is relatively near the surface. As mentioned above (see, paragraph 30), irrigation of dryland soils, unless very carefully managed, can lead to their irreversible degradation through salinisation, waterlogging and other impacts. Disposal of saline irrigation water can also have a severe impact on biological diversity. Creation of artificial water-sources for livestock leads to the creation of virtually barren "sacrifice zones" around the water source as a result of extremely heavy trampling by livestock.

Soil stabilisation and prevention of erosion

37. Dryland soils are particularly prone to erosion, which is one of the major causes of land degradation. Erosion may be a product of wind or of water. The

former may intuitively be expected to be the most serious hazard in drylands. In reality, the sporadic but often intense nature of rainfall events in drylands and the limited capacity of the soil to absorb the resulting rainfall, means that surface runoff and erosion can reach very high levels.

38. Thus, natural vegetation cover plays a major part in reducing soil loss by erosion and by enhancing retention infiltration resulting in increased availability of the limited and sporadic precipitation that does fall. Moreover, natural vegetation cover also prevents or mitigates land degradation.

Chemical inputs

39. In many grassland ecosystems, highest biological diversity surprisingly seems to be associated with poorer soils. Artificial enrichment of grasslands, particularly through application of nitrogenous fertiliser, generally leads to a very marked decrease in plant species diversity.

Harvesting of wood for fuel

40. One of the most significant human impacts in natural or semi-natural dryland and savannah ecosystems in developing countries is harvesting of wood for fuel. Quantifying this practice and assessing its long-term impact on ecosystems has proved problematic, although in some areas the impact is undoubtedly severe.

Overharvesting of wild species

41. Overhunting of wildlife and overcollection of plants, whether for subsistence use or national or international trade, can have severe impacts, in some cases driving species to extinction. Because dryland species tend to have relatively low population growth rates, and in the case of plants, individual growth rates, they may be particularly sensitive to overharvesting.

Long-term impacts of climate change

42. The potential impacts on dryland ecosystems of human-induced climate change remain to be quantified but are likely to be significant. These various impacts might interact in a complex and sometimes unpredictable way. Moreover, most adverse impacts, including climate change, that lead to some form of land degradation in drylands can be classified as desertification.

43. Under the United Nations Convention to Combat Desertification, desertification is defined explicitly as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities". This Convention further defines land degradation as "reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as:

- soil erosion caused by wind and/or water;
- deterioration of the physical, chemical and biological or economic properties of soil;
- long-term loss of natural vegetation".

44. Regarding the definition mentioned above, hyperarid lands, which means true deserts, are not susceptible to desertification, as their productivity is already so low that it cannot be seriously decreased by human action.

45. According to the United Nations Environment Programme (1997), desertification directly affects some 36 million square kilometers of the world's drylands - about 70 per cent of the total - and one-sixth of the world's people. The effects of desertification promote poverty among rural people and, by placing greater stress on natural resources, poverty then tends to reinforce any existing trend toward desertification.

7. V. CURRENT STATUS OF THE BIOLOGICAL DIVERSITY OF DRYLAND, MEDITERRANEAN, ARID, SEMI-ARID, GRASSLAND AND SAVANNAH ECOSYSTEMS

46. Summary analysis of the habitat distribution of globally threatened mammals and birds shows clearly that while the majority of species occupy forest habitats (particularly lowland tropical moist forest), drylands, scrubland and grasslands make up the second most important group of threatened species habitats and are somewhat more critical for mammals than for birds, for whom wetlands are more significant. At present, there are generally insufficient data overall to determine whether species in the ecosystem types under discussion are relatively more or less prone to extinction than those elsewhere – that is whether a higher or lower than average proportion of species in these ecosystems can be classified as threatened. However, for some groups and some locations more detailed information may be available.

47. With respect to mammals, a high percentage of continental (as opposed to island or marine) species believed or known to have become extinct since 1600 occurred

in dryland ecosystems, most notably in Australia. It is unclear whether this reflects a high vulnerability of species in those ecosystems, or if it is due to the special situation of Australia, in which invasion of alien species, both domestic (grazing livestock, cats) and wild (foxes, rabbits) appears to have had a catastrophic impact on the fauna globally. In general, dryland mammals tend to be relatively wideranging but to occur at low population densities because of the low primary productivity of these areas. Larger species are also more conspicuous (and in the case of ungulates, more gregarious) than forest dwelling species and thus more vulnerable to overhunting.

48. These factors have meant that a notable number of large dryland mammals are either highly endangered (for instance: Dama Gazelle (Gazella dama) and Slender-horned Gazelle (Gazella leptoceros) in the Sahelo-Saharian region - the Wild Dog (Lycaon pictus) in sub-Saharan Africa - the Bactrian Camel (Camelus bactrianus) - and Przewalski's Gazelle (Procapra przewalskii) in eastern and central Asia) or extinct or probably extinct in the wild such as the Addax (Addax nasomaculatus), Scimitar-horned Oryx (Oryx dammah) and Arabian Oryx (Oryx leucoryx), although all these are currently the subject of reintroduction programmes.

49. The Mediterranean-type ecosystems in general have a relatively high proportion of their species categorised as threatened. This is in part a consequence of human land-use development in agriculture, industry and housing and, especially in the Cape and California regions, of the spread of non-native plant species. For example, some 10 per cent of the flora in parts of California consist of naturalised alien species, and some perennial grassland has been replaced by annual alien-dominated grassland.

50. The Cape flora, largely within a Mediterranean-type ecosystem, occupies only 4 per cent of the land area of southern Africa, but accounts for nearly 70 per cent of the region's threatened species. About one third of the natural vegetation has been transformed by human activity; the remaining natural vegetation is at risk from a number of invasive introduced woody plants, and the effects of an introduced ant (that suppresses native seed-storing ants and thus renders seed liable to destruction by rodents or fire). Around 10 per cent of the California flora are considered threatened (equivalent to approximately one quarter of all threatened plants in the United States of America). In the Mediterranean region proper, the larger islands have on average 4 per cent (ranging from 2 per cent in Corsica and Malta to 11 per cent in Crete) of their plant taxa considered globally threatened. The main threats are: urban coastal development, pollution, agriculture, tourism, water shortages and fire. In Australia, 'heath' habitats, primarily in the southwest Mediterranean-type ecosystem region, rank third after 'woodland' and 'scrub' in numbers of endangered-category plants. Given their much smaller extent,

this indicates that a far higher proportion of their flora is threatened than in either woodland or scrub habitats.

51. Distinguishing natural grasslands and savannahs from anthropogenic systems, and measuring their area with accuracy is problematic. Anthropogenic grassland now extends through much of the regions originally under temperate forests; some former forest areas are being reafforested at the expense of grassland. Some anthropogenic grassland consists of short-term monospecific sown pasture replacing some of old species-rich semi-natural grassland created over centuries by pastoralists in conjunction with livestock grazing. Cropland has at the same time also replaced much natural grassland, for example in North America, Europe and Central Asia. While the number of grassland species now assessed as globally threatened is more modest than might be expected, this may be because some species, such as the Marmot Steppe in Eastern Europe (once highly threatened by hunting and loss of shortgrass steppe), have been able to occupy other agricultural habitats or to use them temporarily. On the other hand, local areas of high grassland biological diversity, for example in the state of Victoria (Australia), have been severely impacted and have a large proportion of the native plants and animals ranked as threatened. Similarly, although not yet recognised as globally threatened, many species are now in decline and threatened at local or national level.

52. Forests and woodlands, and inland water ecosystems within drylands, tend to be placed under disproportionate pressure. This is chiefly because they are inherently scarce resources but also, in the case of forests and woodlands, because they tend to be found in areas within drylands with somewhat more favourable conditions (microclimate and soil fertility) than normal. These areas are therefore most likely to be settled by people and suffer extensive habitat conversion. Mediterranean ecosystems in particular are noted for their amenable climates and therefore come under particular pressure for, inter alia, permanent settlement and tourism.

53. Even where the number or proportion of globally threatened species is relatively low, in the broad context of desertification issues, conservation status at local level remains a key issue. In Kenya, for example, species diversity in semi-arid areas is decreasing as land is converted to settled agriculture and pastoralism declines. Excess exploitation has also led to serious decline in several species such as Carissa edulis (a fruit plant with medicinal roots), Borassus Palm (poles, palm wine), and the edible Ipomoea species.

8.

9. VI. CONSERVATION OF BIOLOGICAL DIVERSITY IN DRYLAND, MEDITERRANEAN, ARID, SEMI-ARID, GRASSLAND AND SAVANNAH ECOSYSTEMS.

A. Conservation of biological diversity

In situ conservation
Protected areas, including buffer zones

54. One of the major approaches to conservation of biological diversity, as recognized in Article 8 of the Convention, is the establishment and management of a system of protected areas. The dynamic nature of many dryland ecosystems and the migratory and/or nomadic habit of many of the larger animals that inhabit them generally means that protected areas need to be large if minimum viable populations are to be maintained. There is therefore considerable scope for the development of transboundary protected areas in these regions. Conversely, in some circumstances very small protected areas in these ecosystems can be of great value in maintaining populations of particular plants and small animals. This may apply, for example, in temperate grasslands where viable populations of threatened plants are sometimes maintained in areas less than a hectare in extent.

Rehabilitation and restoration of degraded ecosystems

55. At one level, restoration in dryland ecosystems may sometimes be relatively straightforward, as such ecosystems are naturally adapted to widely changing environmental conditions, i.e. may be considered in some senses resilient. Rehabilitation may therefore merely require the removal of the adverse influence (such as the exclusion of livestock or other introduced herbivores, like rabbits in Australia), or the use of fairly simple management techniques (such as mowing or grazing by buffalo to restore diversity in anthropogenically-stressed prairie grasslands in North America).

56. On the other hand, where serious soil degradation is involved, recovery may be very slow or negligible as rates of soil accumulation can be extremely slow in dryland areas. Dryland forest restoration in particular appears to be a difficult and slow process, given the slow growth rate and long regeneration times of many dryland trees. Often land rehabilitation, such as stabilisation and anti-erosion measures, in degraded forest areas is carried out with non-native species (Tamariscus, Pinus caribbaea, Eucalyptus spp.) which may have limited value for biological diversity and may indeed have adverse ecological impacts (through, for example, increased uptake of groundwater resources and increasing acidity of soils through leaf fall).

Use of indigenous knowledge in in situ conservation

57. In some areas that have been under human influence for long periods, maintenance of current levels of biological diversity appears to be contingent on continued human intervention. This applies, for example, in many species-rich semi-natural grasslands in temperate regions, particularly Europe, whose long term integrity relies on the maintenance of traditional livestock grazing regimes with no or very low fertiliser input. Increased chemical input generally results in significant loss of diversity. Conversely, abandonment of grazing or mowing often results in grasslands being replaced by later successional stages with lower diversity, at least at fine scales.

58. Similarly, maintenance of a number of dryland, grassland, savannah and Mediterranean-type ecosystems depends on careful control of the fire regime. In some cases, fairly frequent, low-intensity deliberate burning may be preferable to high intensity, infrequent fires that would result if there were no human interference. This is the case, for example, in the spinifex grassland communities of the Tanami Desert, Australia, where knowledge and practices of local people are used to help maintain optimal habitat for a number of species, including the threatened Rufous Hare-wallaby Lagorchestes hirsutus.

Ex situ conservation

Biological diversity of fauna

59. As already mentioned, many larger dryland, grassland and savannah species, particularly ungulates, have become seriously threatened with extinction, primarily through overhunting. Fortunately, a number of these species have proved tractable in captivity, and indeed represent some of the relatively few cases where captive-breeding can be said to have had a significant beneficial impact on the survival of a species. One species, the Arabian Oryx Oryx leucoryx, and probably two others, the Addax (Addax nasomaculatus) and the Scimitar-horned Oryx (Oryx dammah), owe their continued survival to captive-breeding programmes. All are currently the subject of reintroduction programmes in various countries. Similarly, in North America the Black-footed Ferret (Mustela nigripes), a prairie-dwelling carnivore and specialist predator on prairie dogs (Cynomys spp.), would probably now be extinct were it not for a captive-breeding and reintroduction programme.

Biological diversity of flora

60. It is to be recalled that botanic gardens have played an important role in helping maintain populations of a significant number of threatened dryland and

Mediterranean plant species, particularly cacti (family Cactaceae) and other succulents. To date, however, relatively few successful reintroduction programmes have been undertaken.

10. B. Sustainable use of the biological diversity of dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems

11.

61. Drylands are home to about one fifth of the world population, or over one billion people (UNEP, 1997). Humans have made great use of the biological diversity of drylands in a variety of ways. Many of these people constitute the indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity (Article 8(j)) of the Convention on Biological Diversity).

62. Where appropriately managed, many of the uses of dryland, Mediterranean, semi-arid, grassland, and savannah ecosystems should be sustainable, in the sense understood by the Convention on Biological Diversity, which defines “sustainable use” as: []"the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations”.

Existing crops and livestock and their wild relatives

63. Dryland, grassland and Mediterranean ecosystems are the centres of origin of a significant proportion of the world’s major crop plants, including most cultivated species of Gramineae (such as barley, rye, wheat and millet) and a number of leguminous plants (such as chickpeas, lentils, peas and broad beans) and fruit and nut trees (e.g. pistachios, almonds, cherries). Populations of wild relatives of many existing crops still persist in dryland regions and are potentially very valuable genetic resources. Primary domestication of most major livestock species (such as sheep, goats, cattle, donkeys, cats and dogs) is believed to have taken place in dryland or Mediterranean ecosystems (most notably in the so-called Fertile Crescent in the Middle East), although the ancestors or close wild relatives of most of these species are not necessarily confined to such systems.

Wild foods

64. A small number of people inhabiting dryland, grassland, savannah and Mediterranean ecosystems (for example, in southern Africa and central Australia) still rely entirely or almost entirely on wild foods through hunting and gathering. A far greater number may supplement their diet from such foods or may rely on them as famine foods. In the unpredictable conditions of arid and semi-arid regions,

the latter foods may be intermittently of crucial importance in preventing starvation. Under such circumstances, a wide range of plant species is typically used.

Pastoralism

65. Grazing of domestic or semi-domestic livestock is a major land use in most of the world's drylands (for which 'rangelands' is essentially a synonym in this context). Pastoral nomadism remains one of the most productive uses of the more arid drylands, and transhumance, with regular medium-range movements of stock and pastoralists between winter and summer grounds, makes effective use of seasonal and elevational variations in productivity in mountainous grasslands. Although often subject to deliberate regular burning and other forms of perturbation or management (through, for example, fencing, elimination or control of wild animal species and provision of artificial water supplies for livestock), extensive pastoral systems generally have negligible artificial inputs in the form of fertilisers or other chemicals, and are therefore reliant on natural ecosystem productivity and resilience.

Wildlife tourism

66. Grassland and savannah areas with major concentrations of large and wild mammals include many of the most important sites for wildlife-based tourism. Of particular note are a number of national parks and reserves in eastern and southern Africa. Major destinations for nature-based tourism in North America (Banff, Jasper and Yellowstone National Parks and the Grand Canyon) are also entirely or largely in dryland areas. This association is not coincidental. Large-scale wildlife tourism is strongly dependent on concentrations of preferably diverse large animals that are reliably visible. These conditions are only met in open habitats. In woodland and forest ecosystems, on the contrary, large animals tend to occur at low population densities, are often cryptic or nocturnal, and usually actively shun humans. Furthermore, in contrast to tropical moist forests or polar regions, for instance, grassland and savannah areas often have an amenable climate, which encourages tourism (predictable dry season with moderate or low humidity and warm or tolerably hot temperature).

12. C. Equitable sharing of benefits arising from the utilization of genetic resources

67. Many of the ecosystems under consideration here are potentially valuable repositories of genetic resources, as developed below. Not only are they the source

of many cultivated species, but the wide ranges of many of these species, and the often adverse and variable environmental conditions they are adapted to, mean that there is considerable genetic variation within wild populations, which may offer great potential for increasing productivity of cultivated crops. Developing mechanisms for ensuring equitable sharing of any benefits resulting from such increased productivity poses considerable challenges, particularly in view of the transboundary distributions of many of the species concerned.

68. In this perspective, Article 8 (j) of the Convention on Biological Diversity needs to be taken into account because many of the indigenous and local communities which inhabit and use the ecosystems under consideration, and who are conservers, users or promoters of biological diversity, are amongst the most impoverished in the world. In light of the finding that " poverty tends to reinforce any existing trend toward desertification", (as mentioned above, paragraph 46), resulting in a reduction or loss of biological diversity, serious consideration needs to be given to the equitable sharing of benefits arising from the use or application of the traditional knowledge, innovations and practices associated with the genetic resources of these ecosystems, in accordance with Article 8(j) of the Convention on Biological Diversity.

Potential new crops

69. There is potential for new crops to be selected and developed for use amongst species from these ecosystems. Of particular interest are salt-tolerant or halophytic species, such as Salicornia spp. and some Atriplex and Distichlis spp. As discussed above, salinisation of irrigated croplands in dryland areas is one of the most intractable problems in food production in such areas, and one whose effects are extremely difficult, and expensive, to reverse. Use of halophytic species may help circumvent this problem and their potential use is already being experimentally investigated.

Medicinals

70. In many developing parts of the world (particularly in much of Africa and south Asia), local people rely very heavily on medicines from wild plants and, to a lesser extent, wild animals and minerals. This is generally for both economic and social reasons. In the first instance, "modern" pharmaceuticals are largely unaffordable; in the second, traditional medicines are the culturally preferred remedy for many problems and ailments. Plant species used in traditional medicines may also be traded internationally, sometimes in large quantities. Some species are used to produce conventional pharmaceuticals, others to service the increasing demand for herbal remedies in developed countries. Amongst plants from arid and semi-arid

areas, the Madagascar Periwinkle (Catharanthus roseus) is an example of the former, being a source of the drug vincristine (used to treat childhood leukaemia) as well as a large number of other alkaloids. Examples of the latter include Harpagophytum spp. from southern Africa, used widely to treat rheumatism and arthritis, and Aloe spp, from southern and eastern Africa and the Middle East, used for a range of purposes, including as a purgative and in cosmetics and shampoos. Some widely used medicinal species of drylands are in part cultivated; others (for example, Catharanthus roseus and Aloe vera) are now established in many parts of the world as introduced plants.

Aromatics and stimulants

71. Arid, semi-arid and Mediterranean regions support a high proportion of plants rich in secondary compounds such as terpenes, which may have aromatic properties. Exudates and extracts from such species may be of considerable economic importance. Examples are: frankincense (Boswellia sacra) and myrrh (Commiphora spp.), used in perfumery, khat or qat (Catha edulis) used as a stimulant, and herbs such as lavender (Lavandula spp.), rosemary (Rosmarius spp.), and thyme (Thymus spp.). As with medicinal plants, many of these are now widely cultivated, although frankincense and myrrh are still collected from wild plants.

Ornamentals

72. Arid and semi-arid and Mediterranean-type ecosystems have proven important sources of ornamental plants, with many thousand species nowadays in cultivation outside their natural ranges. The vast majority of such plants are now artificially propagated. However, there is still some demand for wild-collected plants, particularly cacti and other succulents that are popular with specialist collectors.

13. VII. RECOMMENDATIONS

14. A. Relationship with other thematic programmes under the Convention on Biological Diversity

73. Consideration of dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems has considerable overlap with other activities and processes already in progress under the Convention. The most significant direct areas of overlap are with the Convention's work programmes on agricultural biological diversity and on forest biological diversity. This is because a very significant proportion of the ecosystems under consideration here are also agricultural ecosystems. A notable, although smaller, proportion are forest ecosystems.

74. The Subsidiary Body on Scientific, Technical and Technological Advice may wish to consider recommending that the existing work programmes be modified to take into account (i) the special problems of maintaining agricultural biological diversity in dryland, Mediterranean, grassland and savannah ecosystems and (ii) the special circumstances of forests in dryland and Mediterranean ecosystems. It may wish to consider recommending that these be considered as focal issues under the work programmes for agricultural biological diversity and forest biological diversity respectively.

75. There is also overlap between consideration of dryland and grassland ecosystems and consideration of inland water ecosystems. In the first instance, this is because inland water ecosystems in dryland areas are generally under far greater pressure from human influence than these ecosystems elsewhere. Any approach and analysis of the biological diversity in these systems will have to take into consideration water use and water balance within the catchment as a whole. Secondly, many seasonally flooded areas are intermediary between grassland and inland water ecosystems. Because of their high productivity, such areas are often of great importance for biological diversity, and are also frequently under considerable pressure from human activities.

76. Therefore, the Subsidiary Body on Scientific, Technical and Technological Advice may also wish to consider emphasising the importance of inland water ecosystems in dryland areas, and suggesting that the work programme on inland water ecosystems take this into account.

15. B. Relationship with other international processes

1. The most important relevant international process to be considered regarding the ecosystems discussed in this document is undoubtedly the United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa. This Convention explicitly deals with areas susceptible to desertification, defined as those areas where P/PET falls within the range of 0.05 to 0.65 . It therefore excludes hyperarid regions or true deserts (where P/PET is less than 0.05). Within the context of the present discussion, it also excludes those grassland, savannah and Mediterranean ecosystems that lie within humid regions, where P/PET is more than 0.65.

2. As noted above, the definition of desertification in the Convention to Combat Desertification includes reduction or loss, in susceptible drylands, of the biological productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns. This can be interpreted as referring explicitly to a reduction or loss of biological diversity.

3. In its Article 4, paragraph 2 (a), the Convention to Combat Desertification states: "In pursuing the objective of this Convention, the Parties shall: adopt an integrated approach addressing the physical, biological and socio-economic aspects of the processes of desertification and drought;"

4. Further, in its Article 8, the Convention to Combat Desertification also calls on Parties to "encourage the coordination of activities carried out under this Convention and, if they are Parties to them, under other relevant international agreements, particularly the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity, in order to derive maximum benefit from activities under each agreement while avoiding duplication of efforts. The Parties shall encourage the conduct of joint programmes, particularly in the fields of research, training, systematic observation and information collection and exchange, to the extent that such activities may contribute to achieving the objectives of the agreements concerned."

5. From the perspective of the Convention to Combat Desertification, there is a clear mandate both to consider reduction or loss of biological diversity, and to develop joint work programmes with the Convention on Biological Diversity. In this regard, the Memorandum of Cooperation that the Secretariat of the United Nations Convention to Combat Desertification and the Secretariat of the Convention on Biological Diversity have signed on 31 July 1998 constitutes a first step for furthering such development of joint activities.

C. Important ecosystems not covered by other processes

6. A number of ecosystem types in dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems are not covered by the current thematic programmes under the Convention on Biological Diversity while also falling outside

the remit of the Convention to Combat Desertification. These include hyperarid regions (true deserts), natural (uncultivated or unpastured) savannahs and grasslands in humid areas and Mediterranean heaths and other scrubland formations in humid areas. In addition, the emphasis of the Convention to Combat Desertification is focused on developing countries. Today, a considerable proportion of the world's susceptible drylands is found in developed countries, notably in Australia and North America and to a lesser extent in the northern part of the Mediterranean basin.

7. From the perspective of biological diversity, the richest such areas are undoubtedly Mediterranean heaths and other scrub formations in humid areas. These ecosystems also have in many cases a high proportion of threatened species and are by any criteria of great global importance for biological diversity. Other rich areas include temperate region natural or semi-natural grasslands and humid-climate savannahs, particularly in eastern Africa and, secondarily, in northern South America.

8. In this regard, the Subsidiary Body on Scientific, Technical and Technological Advice may wish to consider recommending the adoption of a specific programme of work on drylands under the Convention on Biological Diversity to cover some or all of these areas, laying particular emphasis on the role that the protected areas could also have in maintaining biological diversity in these ecosystems. Such a programme could also play a coordinating role vis à vis the other thematic programmes under the Convention on Biological Diversity that relate to dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems issues. SBSTTA might also consider the need and the required financial resources to appoint and support a Programme Officer to be dedicated to such a programme.