EARTHWATCH

GLOBAL ENVIRONMENT MONITORING SYSTEM

GEMS
REPORT SERIES
NO. 19

NAIROBI
JULY 1993

VEGETATION CLASSIFICATION

Report of the UNEP-HEM/WCMC/GCTE Preparatory Meeting
Charlottesville, Virginia, USA
24-26 January 1993

United Nations Environment Programme

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UNEP
United Nations Environment Programme
Harmonization of Environmental Measurement

WORLD CONSERVATION
MONITORING CENTRE

Global Change and
Terrestrial Ecosystems

UNEP/GEMS (1993). Vegetation Classification. Report of the
UNEP-HEM/WCMC/GCTE Preparatory Meeting,
Charlottesville, Virginia, USA
Nairobi: United Nations Environment Programme
Ref. GEMS REPORT SERIES No. 19

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REPORT OF THE UNEP-HEM/WCMC/GCTE PREPARATORY WORKSHOP ON VEGETATION CLASSIFICATION

Charlottesville Virginia, USA, 24-26 JANUARY 1993

Summary

Participants met to discuss the need for an improved vegetation classification scheme for global mapping and monitoring, the requirements for such a scheme, the most promising approach to be used, and how best to proceed. The main purpose of the workshop was to prepare the ground for a much larger meeting which should involve all the major groups concerned with collection, dissemination and use of data on vegetation cover.

The major needs for a global scheme were considered to be modelling global change, long-term monitoring of the global environment, and global, regional (and national) vegetation maps. Current schemes were briefly reviewed. Although a plethora of schemes exist, there is no single recognized and accepted classification scheme for vegetation which can be applied across the globe and at all scales. Equally there are no adequate global maps of existing vegetation. Existing schemes generally include a mixture of observable vegetation attributes and predictive parameters (e.g. climate, soils) in the classification which considerably limits their usefulness, particularly in applications involving global change modelling.

After considering the main elements of existing schemes, their advantages and disadvantages in different applications, the sources of data available, and the possibilities for storage, supply and manipulation of data, participants agreed on a basic framework for development of a new scheme. New data handling facilities, in particular the use of GIS, mean that we can now reconsider the whole approach to data compilation and aggregation, and thus to classification. It is no longer necessary to perform massive aggregation and simplification of data at an early stage simply in order to be able to handle it. Even though variables must be able to be grouped into a few classes for the purposes of visual maps, and these basic classes need to be defined on the basis of the classification scheme, this was not the only aim of the scheme. The modern requirement was for a system with a minimum of aggregation and maximum of flexibility allowing for a wide range of different types of analyses in global or regional GIS's. Equally the system should facilitate the aggregation of data from different sources by providing a basic scheme for harmonized data classification and storage.

To fulfil these requirements, the vegetation classification should be divided into thematic layers, each containing a hierarchy of levels, which could be overlayed in different combinations to obtain the classification categories. Since satellite imagery, possibly supported by aerial photography, is the major source of information for global mapping, structure and phenology should form the basis of the scheme, backed up, where necessary, by broad details or diagnostic elements of floristic composition. The core of the system

would be based on observable vegetation characteristics (structure, phenology, floristics). Additional thematic layers would accommodate environmental conditions (climate, topography, habitat etc.), functional use, historical data etc. The diagnostic criteria used to define categories would be quantitatively defined. It was felt that the various requirements of different scales of map (local, national, continental, global, etc.) could also be accommodated in this way, and that vegetation classification schemes used for national maps could be fitted into a global scheme. The scheme should be designed so that a lower level aggregation could be made bearing a close resemblance to the categories at present in common use, albeit more precisely defined. In general, access to the original data should always be maintained to allow full disaggregation, return from boundaries to gradients, and reclassification for other purposes.

Participants agreed on the way to proceed in developing the new scheme. A draft vegetation classification scheme should be prepared along the lines suggested and presented for consideration at a larger meeting comprising some 100 invited experts from different fields and representing different interest groups. A pilot study should be performed prior to the meeting to identify user needs more precisely, prepare the draft scheme, and test it using limited subsets of existing data. The meeting would be held under the auspices of UNEP-HEM, WCMC, IGBP, and ICIV. Preparation for the meeting would be supervised by a scientific advisory group. Assuming funds could be secured for the pilot study, it was suggested that the meeting take place in mid 1994.

1. Opening of the Workshop and Introduction

- The meeting was opened by the Chairperson, R. Leemans, who welcomed participants and outlined the approach which had been planned.
  (The Agenda is attached as Annex I and the List of Participants as Annex III.)

- A. B. Murray briefly summarized the background events leading to the meeting and the aim of the workshop. As the global nature of many environmental issues becomes clearer, vegetation mapping on a global scale is becoming increasingly important. In particular the global change community have an urgent need for a reliable global data set on existing vegetation for validation and further development of global change models. Many other user groups have a need for data on existing vegetation consistent across the globe, e.g. for global assessments of forest cover, biodiversity and desertification. At the same time the availability of high resolution global data sets from satellite remote sensing has brought the possibility of a global map of existing vegetation within reach. Although a wealth of data exists at various scales on vegetation cover, it is recorded and classified according to a large number of more or less incompatible schemes and cannot be meaningfully aggregated to give a true view of the global situation. There is no single recognized and accepted classification scheme for vegetation which can be applied across the globe and at all scales.

The United Nations Environment Programme Harmonization of Environmental Measurement office (UNEP-HEM) as part of the Global Environment Monitoring System (GEMS) is pursuing a number of mainly catalytic and coordinating activities aimed at improving the comparability and compatibility of environmental data on a global scale. UNEP-HEM recognized the importance of developing an improved, practical and widely-acceptable global classification scheme for vegetation classification and has been investigating various approaches to the problem. This task has been pursued in close cooperation with the World Conservation Monitoring Centre (WCMC) which is also linked closely with GEMS. WCMC is a major user of global data sets relating to existing habitats and vegetation in the broadest sense, and is thus particularly aware of the present problem. Scientists in the International Geosphere Biosphere Programme core project Global Change and Terrestrial Ecosystems (IGBP-GCTE), as well as in other IGBP core projects, have a major interest as users in an improved global vegetation classification scheme. IGBP is a programme of the International Council of Scientific Unions (ICSU). At present models used for global change scenarios must rely on non-verified vegetation maps to provide the basis for predicting global change effects. A global map of existing vegetation is urgently needed for model verification and development. These three groups thus joined together to organize a preparatory workshop to explore approaches to developing an improved vegetation classification scheme for global mapping and monitoring.

The main purpose of the workshop was to prepare the ground for a much larger meeting which should involve all the major groups concerned with collection, dissemination and use of data on vegetation cover. Some form of pilot scheme, highlighting practical possibilities and problems, is a prerequisite for the successful functioning of such a meeting. New methods of data handling mean that we are now able to reconsider the whole approach to data compilation and aggregation, and thus also to classification. It is no longer necessary to perform massive aggregation and simplification of data at an early stage in archiving simply in order to be able to handle it. Workshop participants were asked to consider a likely best approach to be used in a multipurpose vegetation classification scheme: what are the user needs and constraints, which attributes must be included, which kept separate, what data is available (or likely to be so in the near future) and at what scales, what framework can be used to enable data obtained at different scales to be linked in a single scheme. Furthermore, participants were asked to consider which organizations and groups should be included in the next meeting to ensure that the wide range of user needs would be taken into account, and that any scheme developed would be potentially capable of broad acceptance.

Participants were provided with a series of background papers (Annex II). The first paper prepared by H. van Gils for UNEP-HEM provided a selective review of vegetation classification systems in use evaluated from the point of view of mapping. The second, prepared by J. Adams for WCMC, introduced a possible scheme, developed mainly from the point of view of vegetation ecology. Further papers were provided on such topics as modelling for climate change impact assessments, an aerial survey approach, the concepts used in determining physiognomic categories and how names are used in vegetation classification.

- H. Shugart briefly summarized some of the points which had arisen during the preceeding GCTE meeting on plant functional types. A number of participants attended both meetings and it was felt to be important that ways be found of linking the concepts of plant functional types to those of vegetation classification. Identifying plant functional types implies discerning a certain degree of commonality in the functional behaviour of different plants or plant groups. Understanding of the concept depends heavily on the scale under consideration (local, regional, global). In a broad sense major vegetation classes, particularly those based on primarily physiognomic features, are likely to be congruent with certain classes of functional types. Much of this work is still in its infancy. A clearly defined vegetation classification scheme which could be used to prepare a map of existing vegetation using clearly defined and consistent categories, and which could be linked (overlaid) to data related to the plant environment, would be an important step forward for research in this field.

- R. Leemans set the meeting into its historical/political perspective. Three issues were highlighted at the Earth Summit (UNCED) in Rio de Janeiro in July 1992, all interlinked by the problem of land use. These were Agenda 21 with its emphasis on sustainable development and the human dimension, the Biodiversity treaty with its consideration of the availability and maintenance of habitats and species, and the Climate convention - which aims to to mitigate the negative effects of climatic change and stresses that the rate of change should not exceed the rate which can be adapted to naturally by ecosystems. All of these issues will require the assembly of global data sets with harmonized information on existing global vegetation. Equally, any newly developed classification must take into account the vegetation attributes which will be needed for dealing with these issues.

- The introductory session was completed by a round-table review of the different experiences of participants and the major points that they felt should be considered in the discussion of new approaches to vegetation classification.

2. Requirements of a vegetation classification scheme

- As an introduction to the meeting, W van Wijngaarden presented the UNEP-HEM paper outlining the essential elements of vegetation classification and mapping, and reviewing the schemes currently in existence. Three basic attributes of vegetation were identified: the physiognomy (structure); floristic composition, and phenology (temporal variation, such as leaf fall). These elements are included in different combinations and to a varying extent in different classification schemes (Table 1). Environmental elements, such as climate (tropical, monsoon, etc.) or habitat (swamp) were often included in classifications, but this reduced the capacity to use vegetation distribution in environmental modelling. Other functional attributes (timber production, grazing, range condition) were often incorporated in maps produced for specific purposes.

  The sources of information for vegetation maps were reviewed, namely ground survey, aerial photography (AP), high spatial resolution satellite imagery (HSR) and low spatial resolution satellite imagery (LSR). Each was appropriate for mapping at different scales and gave information on different elements of the vegetation (Table 2).

  In the discussion, the meeting agreed that satellite imagery, possibly supported by aerial photography, was the only appropriate source of information for global mapping and concluded that structure and phenology should form the basis of a global vegetation classification scheme, backed up, where necessary, by broad details, or diagnostic elements of floristic composition. Because of the ease of varying the scale of outputs using GIS, it was agreed that it was important to focus on resolution rather than scale, and relate to the smallest mappable unit.

  The meeting considered that before deciding on a global vegetation classification scheme it is important to define the objectives, since this is standard practice before preparing any map. The current needs were identified as: modelling global change, producing global, regional (and national) vegetation maps, and longer-term monitoring of the global environment. It was pointed out that other needs might be important in the future, such as monitoring biodiversity as envisaged by the biodiversity convention. This might suggest that future emphasis could be on floristic composition, for example, rather than structure or phenology. Essentially the current needs are many and it is impossible to predict all of the future needs. It was therefore felt to be important to design a flexible system. New data handling facilities, in particular the use of GIS, allow data to be stored at a disaggregated level and to be aggregated later in different ways for different purposes. This led to the conclusion that vegetation classification should be divided into thematic layers (floristics, structure, phenology, climate, etc.)

which could be overlayed in different combinations. It was felt that the various requirements of different scales of map (local, national, continental, global, etc.) could also be accommodated in this way, and that vegetation classification schemes used for national maps could be fitted into a global scheme.

- Work on modelling the effects of global climate change was described by R. Leemans. Effects on vegetation, land use and cover are investigated using the global model IMAGE. This model uses data bases for potential natural vegetation, actual vegetation and human-induced land cover to determine likely future effects of global change. The model also incorporates socio-economic factors. Because of data processing limitations, the model uses a spatial resolution of half-degree squares and a temporal resolution of 5 years. Maps of actual vegetation were needed for comparison with the vegetation biomes and agricultural regions predicted by the model, but currently there were no good global maps available. It was important that the vegetation description used for verification was uncontaminated by climatic elements. Physical structural attributes and phenology were likely to be the key features of importance for such applications. A lot of work was still needed before the potential wealth of data from satellite remote sensing on phenology could be translated into usable values.

- J. Adams presented a suggested vegetation classification scheme which he had prepared on behalf of WCMC after consideration of the limitations of all of the existing schemes. He had used an overview of a range of schemes, including the UNESCO scheme, as a starting point and had modified it in the light of the points identified. He stressed that the scheme should a) emphasise the structural component, b) have clearly defined limits, c) use factors easy to map, d) contain a sufficient number of categories, but not too many (around 20), e) be able to cope with transitions and mosaics, and f) distinguish human-induced vegetation. He explained that certain recognised vegetation types, such as tropical rain forest and swamp, could not be readily distinguished on structural or floristic criteria and that it had been necessary to retain environmental criteria for these. This, in any event, had the advantage of retaining recognised terminology without which the scheme was unlikely to achieve acceptance. Although after some discussion this point was agreed by the workshop, it was decided that such environmental criteria should be relegated to a separate (lower) level in the classification hierarchy, so that they could be ignored if the demands of modelling required this.

In the discussion, the importance of keeping observable vegetation attributes (objective measurements) separate from 'predictors' (interpretive criteria based on ecosystem characteristics) was emphasized. If predicting variables were included at a high level in the scheme, the classification could no longer be used for verification of models or for applications concerned with identifying changing patterns, such as adaptation of vegetation in response to habitat/climate change. In addition the scientific criteria for such predictors were often poorly defined. Mapping at a global scale should not include factors which rely on local expert knowledge. There was an undisputed need for additional ecosystem and geographical information, but it should be available as a separate information layer, to be used in aggregations for selected purposes. J. Adams emphasized the importance of any new system being easily 'recognizable' to those working in the field, i.e. containing similar categories to those already in use. Although the meeting agreed that a certain level of compatibility was essential, it was even more important to recognize that present day needs have in some cases changed radically, and to ensure that the gains to be expected from a novel approach were not sacrificed simply in order to ensure acceptability. With a sufficiently flexible system it should be possible to perform a lower level aggregation which bore a close resemblance to the categories in common use, albeit much more precisely defined. In practice, this 'aggregated' information might well be the most commonly used, but it should not be the highest level in the classification.

The need to differentiate between mapping and classifying was also noted. Complexes should be dealt with at the level of mapping, not in the classification scheme. In general, access to the original data should always be maintained to allow disaggregation, return from boundaries to gradients, reclassify for other purposes etc. This would imply a need for agreement on documentation and on a minimum desirable data set at different scales. The meeting also noted that a compromise might have to be achieved at different scales between available, or potentially available, data (measurable features), and desirable categories.

The meeting thanked Mr. Adams for a very valuable contribution which gave a clear starting point for the discussion of a future system. However, it was felt that major alterations to the structure of this scheme were needed to remove the importance of environmental factors as primary criteria. Further consideration would also need to be given to the quantitative criteria.
Mr. Adams emphasized that he disagreed with the view of the other participants and still considered that the main level of the classification scheme should consist of a small number of easily recognizable categories, defined using a combination of predictive and observational variables. Detailed and separated information on these parameters should be treated as additional information, and not serve as the basis for the scheme.

- F. Blasco communicated a number of background comments on behalf of the Food and Agriculture Organization (FAO). Although the present workshop was primarily

concerned with near natural vegetation, and the FAO is more closely interested in those types of land cover affected heavily by human use, there is clearly a considerable contiguity of interests. FAO agreed that there was a need to address the issues of gradients, ecotones and mosaics. Equally, although a global scheme should certainly have a strong structural physiognomic orientation, the floristic element was important for conservation purposes. Some way of including the dynamic aspects of vegetation arising from human impact should also be considered. These needs might best be met by having separate data layers. The UNESCO scheme should be used as a starting point for any new developments.
The meeting thanked F. Blasco for these comments and noted that FAO was one of the major organizations to be involved in any further activities. Any classification scheme for vegetation must be properly coordinated with newly developed land cover classifications.

- It is clear that remote sensing (RS) will be the primary source of information for global vegetation mapping and monitoring. F. Achard presented an overview of the capabilities of remote sensing for mapping tropical vegetation based on the experience acquired in the TREES project as a starting point for discussion. He pointed out that vegetation which was rapidly changing as a result of human influence, could only realistically be monitored by remote sensing. Any vegetation classification scheme must be a compromise between the needs of the users and the performance of RS techniques. However, the latter were continually becoming more sophisticated and their limitations better understood. Attempts to map vegetation with RS imagery had shown which features shown on conventional vegetation maps could be distinguished and which could not. Conversely, some features were distinguishable from RS which were not differentiated in current vegetation classification systems. Total vegetation cover and certain aspects of phenology were very apparent from RS, but it is currently very difficult to determine vegetation height accurately, as is required, for example, by the scheme proposed by J. Adams. Considerable advances can be expected in the future in the interpretation and use of RS data, although progress is hampered by the lack in many areas of recent ground truth data, and of the detailed information on specific aspects of phenology, which is needed for verification.

There is a compromise between the use of high spatial resolution data, which cannot show rapid changes, and low spatial resolution data which is capable of showing seasonal variation and is therefore the main tool available for determining phenology. Consideration should be given to using low spatial resolution data to map globally, and high spatial resolution data to validate the interpretation in selected areas. Similarly once high resolution mapping has been performed, monitoring for change can be performed with low resolution data using, for example, some spectral indicators which are characteristic for fires and road openings in tropical areas. The inherent time scale limitations of different data sources are also important in the monitoring of changes in vegetation cover. Very careful attention will therefore need to be given to the problems of spatial and temporal resolution.

- F. Blasco gave a presentation on the practical experience of vegetation mapping. He identified three major classes of vegetation: unmodified plant communities (mostly dense forest); intensively managed land (crops and plantations); and plant communities which show some intermediate degree of human intervention. The latter comprise by far the greatest proportion of the world's land surface. Noting that there were no adequate global maps of existing vegetation, he pointed out that potential vegetation maps were of great value when conducting a new vegetation survey as they set limits on the types of vegetation one could expect to find in a given region. Comparison with the final maps of actual vegetation gave an indication of the effects of human influence.

  F. Blasco pointed out that the high resolution data available from SPOT or TM produced such detail that not only were the boundaries very difficult to map but the time required to produce maps from them was inconsistent with the timescale required for monitoring habitat change. He believed that NOAA data offered great potential for detailed information on vegetation, but that further technical developments were necessary before their full potential would be realised. In many areas it was very difficult to obtain good quality NOAA data with long time series. Wherever possible his institute tried to use consistent vegetation classification and cartographic conventions in all their mapping, but minor variations were necessary in some regions. He considered that the design and adoption of a uniform global scheme was desirable and believed that he would be able to apply it in national and regional maps.

3. Conceptual framework for a vegetation classification scheme

Following discussion, the workshop proposed that the best approach was likely to be a multi-layer vegetation classification system of the general form shown in Figure 1. Each thematic layer would have a number of different levels, the first of which was to be used in the primary classification system and the subsequent levels in successively more detailed subdivisions of the classification. General features of the system are that it should: a) be hierarchical and largely independent of the final scale of the map; b) be based on diagnostic criteria which are quantitatively defined, avoiding subjectivity; c) be based primarily on vegetation characteristics, avoiding classification by environmental criteria as much as possible. In a further extension of these ideas it was suggested that the thematic layers could be considered in groups relating to: 'actual' vegetation (structural, compositional, phenological data); environmental conditions (climate, soils, topography); functional use (natural resource uses); historical data ((natural disturbance, human disturbance). Examples of the different information which might/should be included at different levels of each of the thematic layers were discussed.

Points which emerged in discussion are listed below under the thematic layers to which they apply.

Structure (Physiognomy)

The primary layer of classification would be based on structures using the generally accepted terms, forest, woodland, shrubland, grassland, bare ground, etc. Distinctions between the categories were to be made on the basis of the relative proportion of ground cover of trees, shrubs, and grass (including forbs). The former two plant forms were to be distinguished primarily on the basis of height. The primary source of this information would be from aerial photography and high spatial resolution satellite data.

There was great concern that satellite data would not allow the determination of height sufficiently accurately, and this problem was to be investigated further. It was suggested that vegetation height and projected area cover should be maintained in different layers to aid modelling, but this idea was rejected.

Phenology

Phenology was identified as the second most important attribute of vegetation with the basic categories of evergreen and deciduous. Seasonality of primary production was also considered to be important, particularly in grasslands, together with the timing of the onset of greening and its duration. Data were expected to come from RS using NDVI values. Three basic patterns were identified: more or less continuous production throughout the year; a single, usually prolonged, period of increased production; and two or more peaks of elevated production separated by non-productive periods. Certain vegetation types defined in terms of structure, such as savannah, might be easiest to recognise from RS by their distinctive phenology.

Composition

Floristic composition, particularly at the species level, was not considered to be particularly useful in a global vegetation classification, because individual indicator species are rarely widespread and frequently occur in different assemblages and different vegetation types.

However, certain higher level taxonomic groupings, such as broad-leaved or needle-leaved, could readily be used in a global scheme. Family-level groupings, such as Cactaceae or Dipterocarpaceae, could also be useful at a lower level in the hierarchy, but genus- or species-defined classifications were likely to feature only at the lowest levels.

Environmental data

While it was agreed that it was important to have environmental data out of the classification system as much as possible, certain recognised vegetation types could only reasonably be distinguished on this basis. The most debated example was tropical rain forest, which could only reasonably be separated from other broad-leaved, evergreen forest by environmental temperature, there being no obvious structural or phenological criteria available. Similarly, it was thought futile to attempt to define "swamp" by anything other than hydrological criteria. However, it was decided to keep any necessary environmental criteria in a clearly separate level of the system, so that they could be excluded by aggregation, if necessary.

Human Influence

While it was not the aim of this meeting to define land-use types, the human influence on vegetation is so pervasive that it was thought essential to include it in the system. This would include such obvious categories as cropland, pasture and plantation, but also potentially more indistinct factors, such as secondary or logged forest, or grassland maintained by burning. Inclusion of these data in the system would be particularly useful for conservation monitoring and it might even be possible to consider including future human impact (e.g. forest designated for logging).

General

The characteristics to be used at each level of each of the thematic layers need to be selected and the boundaries defined. Classification of types of vegetation means defining a set of attributes that determine specific vegetation classes. By keeping data layers separate it would be possible to use different combinations of features for different purposes. One important piece of information which was not yet included as an identifying feature was the 'texture' or 'pattern' of the remote sensed image (plantation stripes etc.)

4. How to proceed

- It was agreed that a new global vegetation classification scheme was needed and that efforts should be made to define and promulgate one using as a basis the broad outline agreed at the workshop. The scheme should take advantage of new data handling and data processing capabilities, particularly those affected by GIS, and should take account of the ability to derive data from RS technology.

- The mechanism for achieving this would be to prepare a draft classification scheme and present it, together with the results of a pilot study, for consideration at a larger meeting, comprising some 100 invited experts from different fields and representing different interest groups. The meeting should be held under the auspices of UNEP-HEM, WCMC, IGBP, and the Institut Carte Internationale de la Vegetation (ICIV).

- Preparation for the meeting would be supervised by a scientific advisory group (SAG) comprising: Professor F. Blasco (as Chairman), Dr M. Collins, Dr R. Leemans, Dr J.-P. Malingreau, and Dr. W. van Wijngaarden, together with others to be decided. Their brief would be to identify those to attend, including invited speakers, and to structure the agenda. UNEP-HEM would coordinate the arrangements for the meeting.

- Workshop participants were asked to suggest to the SAG names of those who should attend the meeting. They should be drawn from the fields shown in Table 3.

- Before the meeting, a pilot project was to be undertaken to prepare a suggested scheme and to test it out using existing data. Subject to the availability of funds, W van Wijngaarden is prepared to direct/supervise such a pilot study, with assistance from others as appropriate.

- The terms of reference of the pilot study should be as follows:

    1. Identify the needs of the various users of a global vegetation classification system. These should include biogeochemical modelling, hydrological modelling, GCTE modelling, GCM modelling, biodiversity and conservation, sustainable development and resource use, mapping and (botanical) inventories. Consideration should be given to the parameters and spatial and temporal scales. (Participants agreed to supply preliminary information on the parameters of interest in particular fields as outlined in Annex IV.)

2. Detail the top levels of a classification system, using the framework agreed at the workshop. Quantitative criteria for dividing the attributes suggested into a mappable legend should be suggested.

3. Identify possible sources of the data required (and feasibility of collecting data) for mapping vegetation under the suggested scheme.

4. Circulate the scheme to workshop participants and incorporate comments received.
5. Test the scheme using a limited number of subsets of existing data.

6. Identify how the suggested scheme can incorporate vegetation data mapped under existing schemes (and how the scheme fits with existing classifications).

7. Circulate the suggested scheme to keynote participants of the next meeting for comment.

- The consideration of existing schemes prepared by van Gils should be expanded and published as a background document for the meeting. This revision should incorporate additional material which J. Adams would make available.

- WCMC and UNEP-HEM were asked to prepare a project proposal to secure the funds needed to prepare for and hold the meeting. Assuming the funds could be secured within 6 months, it was suggested that the meeting should take place in mid 1994.

Figure 1 General outline of suggested vegetation classification scheme

Core of classification system

	Level 1	Level 2	Level 3

A. 'Actual' vegetation, characteristics

1. Structure
(N.B. categories are labelled by generally accepted terms, but definitions are based on objective measurements of parameters such as ground/canopy cover, height, number of layers, spatial pattern etc., parameter data to be stored separately.)

Level 1	Level 2	Level 3
Forest	Dense forest	Patterning?
Woodland	Open forest	
Shrubland	High forest	
Grassland	Forest w/emergents	
	etc.	

2. Phenology

Level 1	Level 2	Level 3
Evergreen	NDVI Profile?	
Mixed deciduous		
Deciduous		

3. Floristics

Level 1	Level 2	Level 3
Broad-leaved	Family?	Species level
Needle-leaved	Genus?	Braun-Blanquet
Succulent	Plant functional types?	

Supplementary

B. Environmental conditions, e.g.

4. Climate
   Temperature
   etc.
5. Topography
   Altitude
   etc.
6. Habitat
   Flooding

C. Historical?

7. Human influence? e.g.

Level 1	Level 2	Level 3
Cropland	Primary forest	Logged forest
Plantation	Secondary forest	Burnt grassland
Pasture		

System	Scale	Used for mapping	Composition	Structure	Phenology	Others
Holdridge	G	+	-	(+)	-	Climate
UNESCO	G	+	(+)	+	(+)	Climate Hydrology
Yangambi	R	+	-	+	-	Hydrology
Veg. map of France	R	+ +	+	+	(+)	
ITC	R	+ +	+	+	-	
Struc. Veg. Class. Can.	R	+	-	+	-	
Eiten	R	?	-	+	-	
Australian Rainforest	R	?	+	+	+	
White	C	+ +	+	+	-	
WCMC	G	-	(+)	+	(+)	Temp.Human impact

G: global; R: regional; C: continental

Table 1. Elements included in different classification schemes

Coverage	Scale, Order of Magnitude	Ground Survey	Aerial Photos	Satellite Imag. High spat. res.	Satellite Imag. Low spat. res.
Local	1: 10^4 ↓	Composition ↓ ⇣	Structure ↓	Structure ↓	
Sub-national	1: 10^5 ↓	⇣	⇣	↓	
National	↓		⇣	↓ ⇣	Phenology ↓
Continental	1: 10^6 ↓			⇣	↓
Global	1: 10^7				↓

Table 2: Different sources of data

Table 3: Preliminary List of Organizations and Fields of Interest to be included in workshop plans

ORGANIZATIONS	
International Government, NGO	UNEP, WCMC, UNESCO, FAO, IUCN, IPCC, WWF, EC (EA task force, JRC)
International scientific	IGBP (GCTE, BAHC, DIS, IGAC), SCOPE (Sustainable Biosphere Programme), HDGCP, IUBS, DIVERSITAS (UNESCO)
Development agencies	World Bank
Conservation organizations	IUCN, Park services
THEMATIC	
Global modelling	GCM/Global assessment, Biogeochemical cycling (C cycle, Atmospheric chemistry), hydrological, biodiversity, sustainable development and resource use
Mapping/inventories	Priority groups working with a range of biomes and biodiversity (arctic, boreal temperate, etc.), groups concerned with regional mapping goals (e.g. Australia, Erin; China; US Interagency WG on Land Cover Use)
Remote sensing	parameters to aid interpretation, input data
Human dimensions	
INDIVIDUALS	
Involved in data collection	biogeographers, ecologists, etc.
With experience of classification systems	

ANNEX I

AGENDA

Sunday 24th January

16.30 - 19.30	'Setting the scene' Welcome and introduction Introduction of participants Aims of the meeting Discussion of the Agenda
20.00	Dinner

Monday 25th January

Morning	'What do we need' Salient issues - experience from mapping Salient issues - needs of the Global Change Community Elements needed in a classification scheme Elements to be avoided/potential pitfalls
Afternoon	'A possible scheme' Presentation of a scheme Discussion: Basic approach, categories missing elements, - assessment in relation to needs
	'What can we use' - practical application Vegetation classification vs. remote sensing (satellite and aerial) and ground-truth data Detectability of categories

Tuesday 26th January

Morning	Vegetation mapping and uses of remote sensing
	'Conceptual framework' - classification scheme and data collection
Afternoon	'How to proceed' Discussion of full workshop: context, participation, background material, major topics
18.00 (Approx)	Closing Remarks

ANNEX II

LIST OF DOCUMENTS

Vegetation Classification, A Review for Harmonization of Maps
Background discussion paper prepared by Dr. H. A. M. J. van Gils for the United Nations Environment Programme Harmonization of Environmental Measurement project.

Towards an Improved Vegetation Classification Scheme for Global Mapping and Monitoring
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ANNEX III

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ANNEX IV

Participants agreed to provide information to W. van Wijngaarden on parameters of interest (or constraints) for specific applications, with consideration of the appropriate spatial and temporal scales, as follows:

Modelling

Biogeochemical	DeFries, Pierce
Hydrological	Pierce, Noble
Biodiversity	WCMC
Sustainable development/ resource use	Noble
GCTE type	Cramer, Leemans
GCM	Halpin
Mapping/ Inventories	Blasco
Remote-sensing (for interpretation)	Pierce
Conservation/biodiversity	WCMC, Luxmoore, Halpin
Human dimensions	Halpin (and IEED)