# PROJECT COMPLETION REPORT

Title: An Assessment of the Status of Conservation Areas in Sabah, Malaysia
Serial Number: PD 3/99

Implementing Agency: Sabah Forestry Department, Sabah, Malaysia
Host Government: Malaysian Government
Starting Date: 2nd May 2000
Actual Duration: 42 months (including 6-month extension)
Actual Project costs: ITTO: USD 345,779.56
Malaysian Government: USD 380,000.00

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Abbreviations used:

| | |
|---|---|
| CA | Conservation Areas.<br>In the context of this project, conservation areas refer to Class I, IV and VI forest reserves. |
| CAIMS | Conservation Areas Information and Monitoring System. |
| FRC | Forest Research Centre.<br>The research and development arm of the Sabah Forestry Department. |
| GIS | Geographical Information Systems. |
| ICT | Information and Communications Technologies. |
| PFE | Permanent Forest Estate.<br>Includes all Class I, II, III, IV, V, VI and VII forest reserves managed by the Sabah Forestry Department. |
| PSC | Project Steering Committee. |
| PTC | Project Technical Committee. |
| RS | Remote-sensing. |
| SFD | Sabah Forestry Department.<br>State government agency responsible for the implementation of Project PD 3/99. |

# PART 1: EXECUTIVE SUMMARY

## 1. BACKGROUND

### 1.1 Conservation Areas in Sabah and pre-project situations

The Sabah Forestry Department (SFD) is responsible for the administration and management of about 3.6 million ha of forest reserve land gazetted under the Forest Enactment 1968. The Enactment provides for 7 categories of forest reserves, collectively referred to as the Permanent Forest Estate (PFE).

The PFE makes up about 48% of the state's total land area of 7.4 million ha. In reality, all forest reserves serve a conservation function to various extents. However, in the context of this project, conservation areas (CA) refer to the Class I (Protection), IV (Amenity) & VI (Virgin Jungle) forest reserves. These CA are made up of 105 forest reserves covering a total of 453,369 ha, or approximately 6% of Sabah.

Prior to Project 3/99, a comprehensive and strategic assessment of conservation areas in Sabah has never been carried out. Below were some issues that needed to be addressed:

- CA did not adequately represent all the various forest types in Sabah.
- The status of the CA in terms of vegetation quality was largely unknown.
- Threats and constraints to the management of CA have to be identified.
- Virtually all conservation areas had no management plans.
- Information on conservation areas was not readily available in a user-friendly format.
- Difficulty in obtaining planting material for reforestation efforts.

In view of all the above, the SFD recognized the need for a statewide assessment of CA to identify management priorities and determine their value in regards to plant biodiversity conservation, education and recreation. The SFD also recognized the need to make information on conservation areas more readily accessible.

### 1.2 Project Objectives

The development objective of Project 3/99, as defined in the Project Document, was *to contribute towards better forest management and conservation by providing baseline information that is vital to the decision-making process*.

The associated specific objectives were:

i) to establish an information system of the CA assessed,
ii) to carry out surveys of the CA, and
iii) to publish the results of the assessment.

### 1.3 Outputs

The outputs of the project were:
i) the establishment an information and monitoring system of the CA,
ii) vegetation surveys of the CA were carried out, and
iii) publication and dissemination of the results.

### 1.4 Project strategy

In general, the project was divided into three main components briefly described below:

*a) Preliminary mapping of target CA*

This involved the preliminary mapping of vegetation and other relevant features such as roads and settlements for all the target CA by the interpretation of aerial photographs and satellite imagery. The maps produced were then used to plan the necessary field assessments.

*b) Field assessments*

In order to verify the accuracy of the preliminary maps produced by remote-sensing methods, field assessments of vegetation were carried out. The purpose of field assessments was also to identify features of special interests, potential threats, presence of key wildlife species (e.g. orang-utan, wild cattle, etc.), and to conduct surveys of forest use by local communities.

*c) Compilation and computerization of information*

This activity refers to the compilation and computerization of all information generated from the field assessments, as well as from secondary sources, for all the target CA.

## 2. PROJECT ACHIEVEMENTS

### 2.1 Specific objectives and outputs achieved

*a) Establishment of the Conservation Areas Information and Monitoring System*

The Conservation Areas Information and Monitoring System, now officially known as CAIMS, was designed and developed by the project team. The CAIMS provides a profile of CA in Sabah. There are currently around 59 viewable reports on conservation areas in the CAIMS. The up-dating of information into the CAIMS is a continuous process. The CAIMS makes information on CA more readily accessible in a user-friendly format.

*b) Surveys of conservation areas*

Field assessments were completed for 72 CA out of the 105 targeted under the Project.

*c) Publication and dissemination of results*

The CAIMS is available on the SFD website at www.sabah.gov.my/htan_caims. The system was also presented at two seminars and two stakeholder workshops to inform the relevant parties of its potential use. Poster presentations were also set up during locally organized seminars, workshops and conferences.

### 2.2 Contribution to the achievement of the development objective

The project aimed to contribute towards better forest management and conservation by providing baseline information that is vital to the decision-making process. To what extent this has been achieved cannot be accurately measured at the moment. Nevertheless, the CAIMS is now being used to re-evaluate the adequacy of the current network of CA in representing the various natural vegetation types found in Sabah. In addition, three CA were identified by the project as priority areas for formulation of management plans, and funding is currently being sourced to carry out this task. The information gathered by the project for these areas form a good basis for drawing up these management plans.

## 3. TARGET BENEFICIARIES INVOLVEMENT

Apart from the SFD itself as the main project beneficiary, other key target beneficiaries of the project include:

- Government agencies such as the Wildlife Department, Environmental Protection Department, and the State Parks,
- Forest Concessionaires,
- Institutes of higher learning, i.e. universities.
- Conservation-related NGOs, e.g. WWF and Malayan Nature Society.

During project implementation, the Sabah Foundation (the largest forest concessionaire in Sabah) contributed information on conservation areas within their concession. The Wildlife Department on the other hand made available results of recent wildlife surveys for various conservation areas. Since the PSC recommended that the CAIMS also include information on state parks, wildlife sanctuaries, conservation areas within production forests, close collaborative efforts with target beneficiaries are expected to continue beyond the approved project period.

During a discussion meeting in October 2003, all target beneficiaries present expressed support and willingness to contribute towards the further development and maintenance of the CAIMS as a one-stop information centre for all conservation areas in Sabah. It was suggested during the meeting that a technical committee comprising key government agencies be formed to coordinate development of the CAIMS. All appreciate the potential value of the CAIMS in the preparation of Environmental Impact Assessments and Forest Management Plans, apart from promoting greater transparency in forest management by making information available on-line.

## 4. LESSONS LEARNED

### 4.1 Development Lessons

*a) Organization's capacity*

Overall, the project was successful in achieving its objectives. The SFD had the professional and technical capacity and did not require any substantial contributions from outside the Department for project implementation. Since the project was basically technical in nature, its implementation was relatively straight-forward. The decision to restrict the focus of the project to 3 classes of conservation areas within Sabah's PFE was made taking into account the SFD's present staff strength and technical capacity. However, it was subsequently realized that certain staff members of the Department could not fully commit to the project implementation due to other job responsibilities. This situation hampered the project's progress to some extent. Therefore, it is important to identify such limitations prior to project implementation.

*b) Interagency collaboration*

The merit of expanding the scope of the project to include other conservation areas apart from those targeted under the project was recognized from the beginning. This would have invariably required a bigger budget and the active participation of other relevant government agencies, such as the Wildlife Department and State Parks. Therefore, the SFD foresaw the necessity to continue project activities beyond the ITTO-funded phase with an expanded scope and other sources of funding. As such, the recently completed project can be considered as an exploratory and development phase towards a fully operational procedure for assessing and monitoring conservations areas in the state of Sabah. As a follow-up to the project, the SFD intends to establish more formal collaborative links with other government agencies as soon as possible. The experience gained from the project puts the SFD at a better position to assist other agencies in carrying out the necessary field assessments.

*c) Project sustainability*

The maintenance of the CAIMS that was developed by the project will now become a routine function of the SFD. In this respect, the sustainability of the project can be safely assumed. The importance of quick and easy access to current information as provided by the system is recognized by all relevant parties.

## 4.2 Operational Lessons

*a) Project organisation and management*

The project implementation was overseen by a Project Steering Committee and the technical aspects were addressed by a Project Technical Committee. The bulk of project activities (ground surveys, field reports, project documentation, monitoring of progress, collation of information, etc.) were carried out by the Project Manager and project officers based at the Forest Research Centre (FRC). The GIS and Cartography Sections at the SFD Headquarters provided mapping and remote-sensing services. This arrangement was very practical and there was no need to alter it during implementation.

Implementation of the project was straightforward as the professional and technical personnel had the necessary expertise and experience. Therefore, the technical risks involved in project implementation were minimal and posed no major obstacles. A major concern in the beginning was the coordination of work schedules among the various sections in the SFD as they had differing priorities at that time. This was addressed in the first six months of the project.

*b) Project monitoring and evaluation*

Good monitoring of the project depended on the ability of the Project Manager to have a clear picture of the progress made in achieving the desired activities as prescribed in the Yearly Plan of Operations. Project officers were required to constantly communicate with the Project Manager on their progress and submit monthly reports. Throughout the project period, 3 PSC and 8 technical committee meetings were held to discuss progress.

*c) Project documentation*

Due to the large number of reports and information that needed compilation and proper documentation, it was absolutely necessary to assign a capable officer the full-time responsibility of carrying out this task. Field reports had to be submitted in a standard format in order to facilitate documentation. Project documentation was continuously updated and made available on-line through the SFD's website.

*d) Project duration*

After the first year of project implementation, it was realised that a three-year period was not sufficient to assess all the 105 CA targeted under the project. This was because field assessments took longer than expected. A six-month extension period was approved by ITTO to offset this delay.

*e) GIS and remote-sensing support*

High-resolution satellite imagery (5 m or less) and aerial photographs were extremely important for mapping vegetation and planning field assessments. Such items are costly and the project budget allowed for their purchase was relatively small. For many areas, the photographs available were outdated. Consequently, more time had to be spent on field assessments and aerial surveys by helicopter. The availability of more current aerial photographs and high-resolution satellite imagery would have certainly accelerated progress of project implementation.

## 5. RECOMMENDATIONS FOR FUTURE PROJECTS

In order to improve the effectiveness and efficiency of future projects of similar nature, the following recommendations are made:

*a) Project scope and staff capacity*

It is extremely important that the scope of the project be defined such that it takes in account the relevant project members commitments to existing projects and other departmental duties. This is necessary to ensure greater focus on the project by the relevant staff members. In the same way, the implementing agency should also assess commitments of collaborating agencies to existing projects.

*b) Inter-agency collaboration*

If the involvement of other agencies is needed, sufficient funds should be made available for their participation. Another alternative is to involve the prospective collaborating agencies in the project planning process so that they may take necessary actions to procure complementary funding.

*c) GIS and remote-sensing support*

The use of high-resolution satellite imagery proved very useful for vegetation assessments and mapping. Therefore, its use should be maximised. Future projects should ensure that sufficient funds are allocated for the purchase of satellite imagery. Projects should also ensure that the full-time support of competent GIS and remote-sensing services is made available.

*d) Wildlife surveys*

The usefulness of the CAIMS would be greatly enhanced if more comprehensive information on wildlife was available. Therefore, it is suggested that future projects allocate an adequate budget for wildlife assessments.

*d) Aerial surveys*

Aerial surveys by helicopter were extremely useful for less time-consuming vegetation assessments, especially where access to certain remote areas were difficult.

*e) Payment of honoraria*

Payment of honoraria to key project staff does ensure greater commitment to project activities. Therefore, future projects should continue to provide such incentives, even if the amount is minimal.

# PART II. MAIN TEXT

## 1. PROJECT CONTENT

### 1.1 Background

Sabah, located at the northern tip of the island of Borneo, is one of the 13 states that make up Malaysia. The Sabah Forestry Department (SFD) is responsible for the administration and management of all forest reserve land in Sabah gazetted under the Forest Enactment 1968. The enactment provides for seven categories of forest reserves, collectively referred to as the Permanent Forest Estate (PFE):

| Class | Type of reserve | Hectarage (ha) |
|---|---|---|
| I* | Protection | 342,150 |
| II | Production | 2,685,119 |
| III* | Domestic | 7,355 |
| IV* | Amenity | 20,940 |
| V | Mangrove | 316,024 |
| VI* | Virgin Jungle | 91,914 |
| VII | Wildlife | 132,653 |
| | Total area: 3,596,155 ha | |

*In the context of this project, conservation areas (CA) refer to the Class I, III, IV & VI forest reserves.

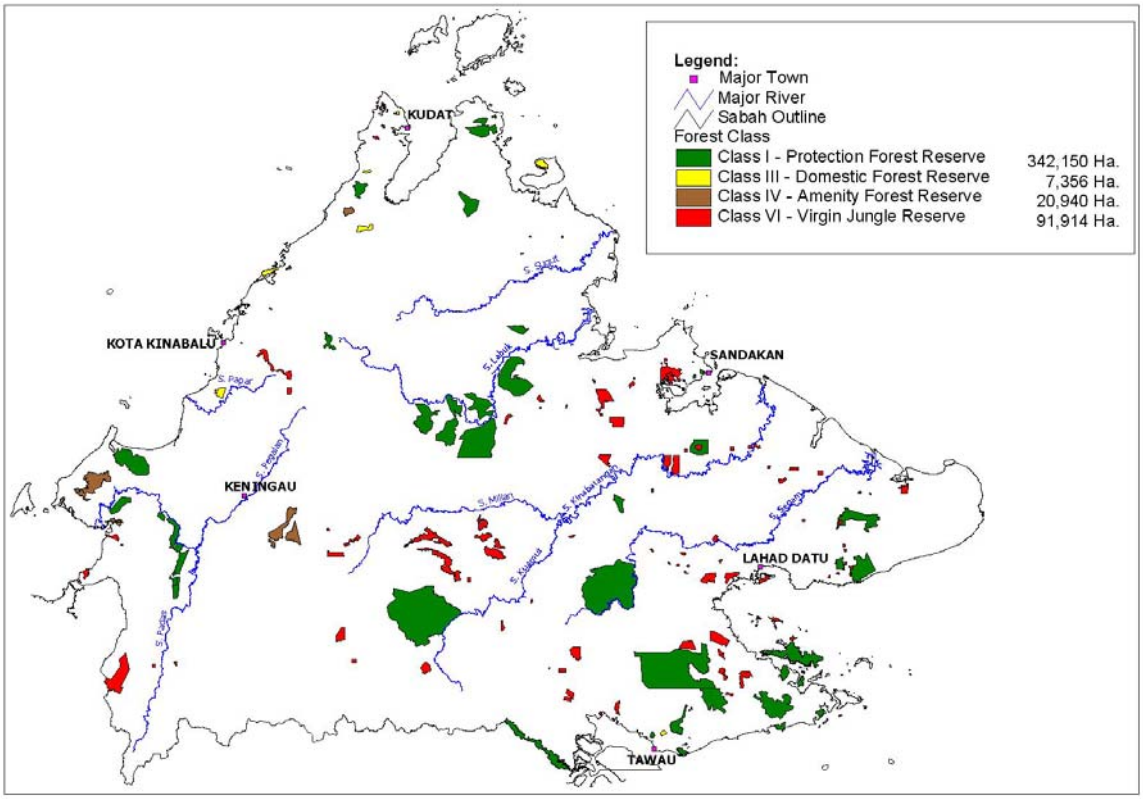



Fig 1: Map of Sabah showing conservation areas in green (Class I), brown (Class IV) and red (Class VI). Although not in the original scope of the project, Class III forest reserves were also assessed under the project.

The PFE covers approximately 3.6 million ha and accounts for about 48% of the state's total land area of about 7.4 million ha. All forest reserves serve a conservation function to various extents. However, in the context of this project, conservation areas (CA) refer to the Class I (Protection), III (Domestic), IV (Domestic) and VI (Virgin jungle) forest reserves. These CA are made up of 105 forest reserves covering about 455,000 ha, or approximately 6% of Sabah. Other conservation areas outside the jurisdiction of the SFD are state parks and wildlife sanctuaries.

## 1.2 Pre-project situation

Prior to Project 3/99, a comprehensive and strategic assessment of conservation areas in Sabah has never been carried out. Below were some problems that needed to be addressed:

*a) CA did not adequately represent all the various forest types in Sabah*.
Many conservation areas were created to preserve their environmental protection functions (e.g. hills and steep slopes), and not necessarily to conserve vegetation diversity. Consequently, a network of CA was created that may not adequately represent the various natural vegetation types found in Sabah. Therefore, an assessment of the types of vegetation the CA represent was needed to formulate a more effective conservation strategy.

*b) The status of CA in terms of vegetation quality was largely unknown.*
Various forms of disturbances have affected the forests in some CA. Prior to their reservation in 1984, many virgin jungle reserves (Class VI) did not have the legal status of forest reserves, and thus, have been logged. It was important for conservation planning to determine the extent of these disturbances and the vegetation quality in these CA.

*c) Threats and constraints to the management of CA have to be identified.*
Rural communities reside within some of the CA. Their activities (e.g. burning, cultivation & livestock rearing) present a potential threat to the integrity of the CA. Land clearing by the slash-and-burn method is commonly practiced during the dry seasons without regard to fire risks. Consequently, fires spread to adjacent CA. For example, a number of CA has been badly affected by fires during droughts caused by the El Niño phenomenon (Jan 98–May 98 & Jan 83–Jun 83). Fire was also a threat to wildlife conservation, especially since most CA in the East Coast are isolated forest fragments, surrounded by extensive oil palm estates. The populations of orangutans, elephants, proboscis monkeys, deer and other mammals are threatened in these small fragments. Such information is very relevant to the management of CA.

*d) Difficulty in obtaining planting material for reforestation efforts.*
In order to ensure the success of any large-scale planting or rehabilitation program, the reliable supply of planting material is of great importance. CA serve as important sources of planting material, i.e. seeds and wildings. Vegetation assessments will help determine the suitability of CA as sources of planting material, as well as determine the kinds of species for which planting material may be available.

*e) Information on conservation areas was not readily available or non-existent.*
Information on CA, especially with regard to vegetation and management, is often requested or required for research and management purposes. Such information is usually not systematically organized, making its retrieval difficult. And for many CA, information regarding vegetation has never been documented.

*f) Virtually all conservation areas have no management plans.*

In order to ensure systematic and proper management, all CA should have a management plan. Prior to project implementation, only one conservation area had a documented management plan, i.e. the Danum Valley Conservation Area. Information derived from this project would make a good basis for the formulation of management plans.

In view of all the above, the SFD recognised the need for a state-wide assessment of CA to identify management priorities and determine the values of CA for plant biodiversity conservation, education and recreation. It was also hoped that this assessment would be a catalyst for the future evaluation of other conservation areas (Mangrove FR, Wildlife FR, State Parks, etc.).

## 1.3 Project Objectives

The Development Objective of Project 3/99, as defined in the Project Document, was *to contribute towards better forest management and conservation by providing baseline information that is vital to the decision-making process*.

The associated specific objectives were:

i) to establish an information system of the CA assessed,
ii) to carry out surveys of the CA, and
iii) to publish the results of the assessment.

## 1.4 Outputs

The Outputs of the Project 3/99 were:

i) the establishment of an information and monitoring system of the CA,
ii) vegetation surveys of the CA, and
iii) publication and dissemination of the results.

## 1.5 Project strategies

*a) Project location*

Sabah was chosen for the following reasons;

- There was an urgent need to evaluate the status of vegetation quality of CA in the state.
- It was in line with the SFD's plan to implement sustainable forest management by the year 2000.
- As a part of Borneo, Sabah plays an important role in the conservation of tropical forest diversity.
- Policies, legislation and establishment of a network of protected forest habitats and their biodiversity required further improvement and refinement.

*b) Methodology*

In general, this Project was divided into three main work components, namely the preliminary mapping of vegetation, field assessment, and compilation and computerization of information. Workflow within the individual components was designed to fit into the work schedules of the participating departmental sections that were involved in Project 6/99. Below is a brief description of each component:

i) Preliminary mapping of vegetation.

This involved the preliminary mapping of vegetation and other relevant features for all the target CA by the interpretation of aerial photographs and satellite imagery. Firstly, stratification of the forest was carried out to differentiate vegetation quality. Other important features mapped out included:

- accessibility and types of roads,
- water bodies (streams, rivers, ponds, lakes, etc.),
- types of vegetation cover and landuse patterns in adjacent lands, and
- settlements.

The maps were then compared with soil association maps to predict previous or current vegetation types in CA. The maps provided survey teams with a general idea of the condition of the CA. Maps produced from this process were used to plan access routes, survey zones/transects and campsites.

ii) Field assessments.

In order to verify the accuracy of the preliminary maps produced by remote-sensing methods, field inventory of vegetation was required. The information derived provided base-line knowledge of every CA such as;

- vegetation types,
- floristic composition and structure,
- status of the vegetation,
- precise locations of the CA and their respective boundary posts,
- land area,
- topography,
- soil associations,
- surrounding land-use,
- accessibility, and
- signs of illegal encroachment.

The purpose of field assessments was also to identify features of special interests, potential threats, presence of key wildlife species (e.g. orang-utan, wild cattle, etc.), and survey of forest use by local communities.

iii) Compilation and computerization of information

This activity refers to the compilation and computerization of all information generated from the field assessments, as well as from secondary sources, for all the target CA.

## 1.6 ITTO context

*a) Compliance with ITTO objectives*

The project contributed to ITTO's objectives mainly in providing information on the vegetation status of selected conservation areas within the Permanent Forest Estate of Sabah. This information is essential for prudent forest management planning, especially in formulating conservation strategies and reforestation activities.

In particular, the project is related to the following ITTO objectives:

a. To help research and development which will improve forest management and wood use;
b. To encourage tropical timber reforestation and forest management;
c. To encourage national policies that aim at sustainable use and conservation of tropical forests and their genetic resources, and at maintaining the ecological balance in the regions concerned.

*b) Compliance with ITTO criteria*

This project directly relates to the areas of natural forest management, reforestation development, training of technical personnel, and national planning. Prior to Project 3/99, a comprehensive and strategic assessment of conservation areas in Sabah has never been carried out. Detailed

information of the natural vegetation they represent and the conditions of these vegetation types are of great importance in conservation planning. Conservation areas are also very important sources of planting material for reforestation. In addition, they provide indications of the type of species that would grow in specific habitats and/or site conditions. Therefore, the project is directly relevant to the production and use of tropical timber, and will yield benefits to the tropical timber economy as a whole in both producer and consumer countries.

*c) Relationship to ITTO Action Plan*

This project is directly in line with the ITTO Action Plan and priorities, as well as national policies and strategies towards sustainable forest management and biodiversity conservation. At the same time it also contributes to Malaysia's commitment to the International Convention on Biodiversity Conservation.

This project will provide baseline information for forest conservation planning on a state-wide scale. It will help identify critical habitats for conservation as well as identify areas suitable as sources of planting material for reforestation.

## 2. PROJECT CONTEXT

### 2.1 Relevance to Government policies

The project is directly relevant to the National Forestry Policy and the National Policy for the Conservation of Biological Diversity in at least, the following aspects:

(i) Providing information on the current status of forest conservation in Sabah with respect to critical habitats, management constraints, and vegetation condition. Ultimately this will allow forest managers to evaluate the adequacy of our conservation areas in conserving Sabah's flora and fauna, and to formulate conservation strategies accordingly;
(ii) Upgrading the management capabilities and providing training for forestry officers in vegetation assessment techniques;
(iii) Identifying areas suitable to serve as sources of planting material, i.e. seeds and wildlings, for reforestation purposes;
(iv) Adding to the documentation and knowledge of biodiversity and its distribution in Sabah.

### 2.2 Relevance to the local socio-economy

The timber-based industry remains one of the most important sectors of Sabah's economy. However, heavy dependence on the industry over the last three decades has resulted in the poor forest resource conditions today. Intensive rehabilitation measures have to be taken in order to improve forest productivity. CA are not just important sources for the supply of planting material for reforestation purposes, but they are also important for research purposes. Certain CA have also tremendous potential to be developed for recreation and eco-tourism. The project will help identify priorities for the management of CA.

## 3. PROJECT DESIGN AND ORGANIZATION

### 3.1 Project identification and definition of scope

The recommendation for a state-wide assessment of conservation areas was the result of a workshop on sustainable forest management organised by the SFD in 1996. Due to the increasing concern about forest conservation both at the national and state level, there was an urgent need to evaluate the status of forest conservation in Sabah. An important part of this task was to gather information on all existing CA, and to assess their value and associated management priorities.

Taking in account the project implementation cycle (i.e. 3 years) as well as the SFD's staff strength and technical capacity, the project's focus was limited to 3 classes of conservation areas:

a. Protection Forest Reserves,
b. Amenity Forest Reserves, and
c. Virgin Jungle Reserve.

### 3.2 Project organisation

*a) Project Steering Committee*

The Project Steering Committee (PSC) was established in April 2000 prior to the commencement of the project in May 2000. It was headed by the Director of the Sabah Forestry Department (Table 1 and Figure 2). The PSC held 3 meetings, *viz*. on the 28th April 2000, 14th December 2001 and 10th December 2002. ITTO representatives were present at the first and third PSC meetings.

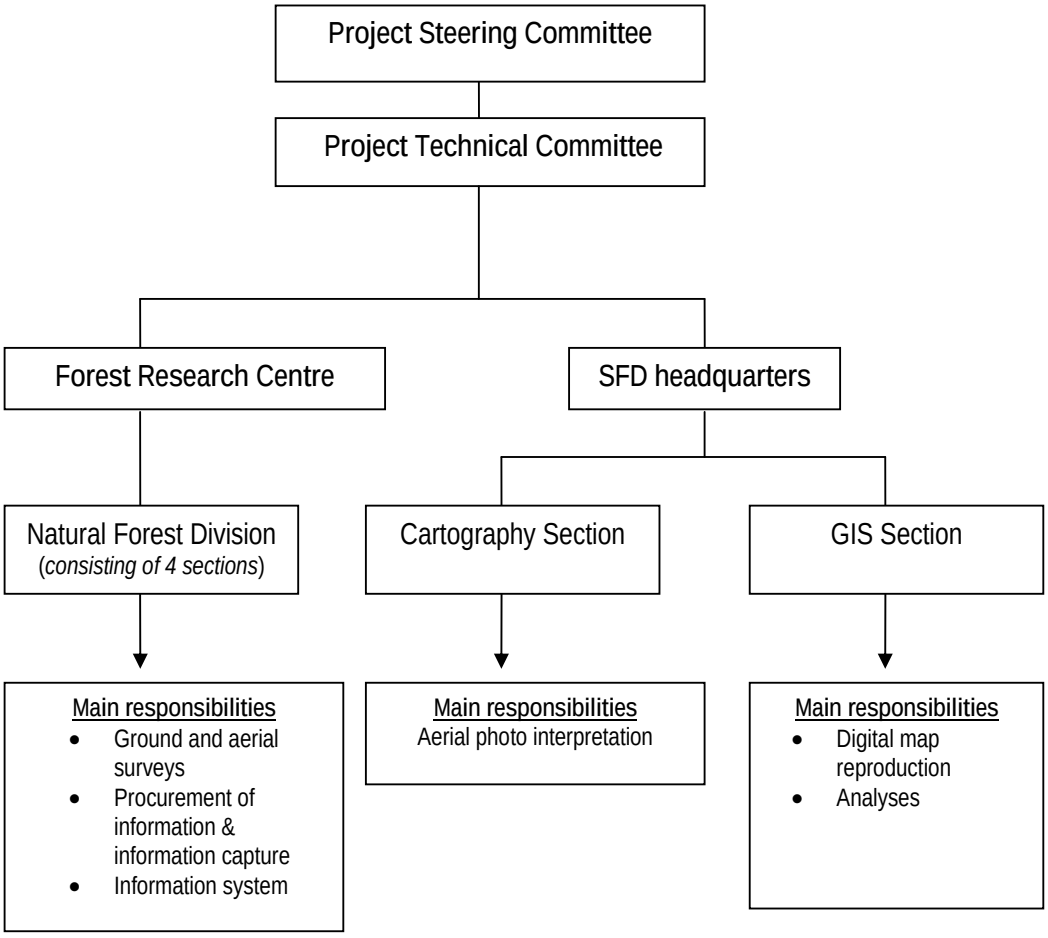
*b) Project Technical Committee*

A Project Technical Committee (PTC) was formed at the start of the project to discuss technical aspects of project implementation. It comprised of officers from the Forest Research Centre, and the Cartography and GIS Sections from the SFD headquarters (Table 1 and Figure 2). Two contract officers engaged full-time on the project were also part of the committee. The committee held 8 meetings during the course of the project.

Table 1: Members of project committees.

| Name | Post | Role in project |
|---|---|---|
| Mr. Daniel Khiong | Director of Forestry | Chairman of PSC |
| Mr. Robert C. Ong | Head, Natural Forest Division | Project Manager |
| Mr. Frederick Kugan | Head, International & External Assistance Division | Member of PSC, Chairman of PTC |
| Mr. Vincent Fung | Head, Planning, Management & Operations Division | Member of PSC |
| Mr. Chak Chee Ving | Head, Forest Information & Management Division | Member of PSC |
| Mr. Reuben Nilus | Head, Ecology Section | Member of PTC, Field ecologist |
| Mr. John B. Sugau | Head, Systematic Botany Section | Member of PTC, Field botanist |
| Ms. Joan T. Pereira | Botanist, Systematic Botany Section | Member of PTC, Field botanist |
| Mr. Joseph W. Tangah | Head, Sepilok Arboretum Section | Member of PTC, Field ecologist |
| Mr. Dimeh Koyopo | Head, Cartography Section | Member of PTC, Aerial photo interpretations |
| Ms. Rosila Anthony | Head, GIS Section | Member of PTC, GIS maps and analyses |
| Mr. Wilfred Lim S. P. | Contract officer | Member of PTC, Field Survey Coordinator |
| Mr. George H. Petol | Contract officer | Member of PTC ,CAIMS |

Figure 2: Organization of Project PD 3/99



## 4. PROJECT IMPLEMENTATION

### 4.1 Planned and actual project implementation.

Generally, there were no serious differences between planned and actual project implementation.

*a) Schedule*

The project implementation period was extended from 3 years to 3.5 years without additional funding from ITTO. This extension was requested because certain activities (i.e. field surveys) took longer than expected.

*b) Output achievement*

In terms of output achievements, the only major difference between planned and actual achievement was in the field surveys of CA (Output II). The project's initial target was to carry out field surveys of 105 forest reserves. However, at the end of the project period, only 72 reserves had been surveyed. Field surveys took longer than expected due to the nature of the work required. For many areas, the project team had to wait for the acquisition of aerial photographs and satellite images because those existing in the department were outdated. This also contributes to a certain extent to the delay in fieldwork.

### 4.2 Expenditures

The total amount of funds received from ITTO was USD 350,200.00, of which USD 345,779.56 (approximately 98.7%) was expended during the course of the project (Table 2). Adjustments to the budget lines were made twice over the project period, with the approval of ITTO. The pre-project estimated total budget was USD 793,820. The Malaysian Government's contribution was approximately USD 380,000, accounting for about 48% of the total project cost.

Table 2: Project Financial Summary as of 31st October 2003.

All amounts in USD. Sums may not add up due to currency conversion (1 USD= RM 3.77)

| | Component | Approved Amount | Expenditures to date | Unexpended Amount |
|---|---|---|---|---|
| 10. | Project Personnel | | | |
| 11. | Project Officers (Honorarium) | 64,500.00 | 64,169.76 | 330.24 |
| 12. | Contract Officers (Salaries) | 94,200.00 | 91,057.90 | 3,142.10 |
| 13. | Clerical Staff | 21,600.00 | 26,128.20 | -4,528.20 |
| 19. | Component total | 180,300.00 | 181,355.86 | -1,055.86 |
| 20. | Sub Contracts | | | |
| 21. | GIS Training | 8,500.00 | 11,140.58 | -2,640.58 |
| 22. | Scientific and editorial services | 4,000.00 | 3,406.90 | 593.10 |
| 23. | Remote Sensing & GIS Services | 51,200.00 | 51,251.62 | -51.62 |
| 26. | Printing and publication of reports | 6,000.00 | 2,538.46 | 3,461.54 |
| 27. | Special surveys | 14,000.00 | 13,684.89 | 315.11 |
| 29. | Component total | 83,700.00 | 82,022.45 | 1677.55 |
| 30. | Duty Travel | | | |
| 31. | Field/Out-stationed allowances | 40,000.00 | 35,249.13 | 4,750.87 |
| 32. | Transport | 15,400.00 | 16,033.08 | 633.08 |
| 39. | Component total | 54,400.00 | 51,282.21 | 3,117.79 |
| 40. | Capital items | | | |
| 41. | Project Office Equipment | 10,000.00 | 16,360.24 | -6,360.24 |
| 42. | Project Field Equipment | 10,000.00 | 3,501.30 | 6,498.70 |
| 49. | Component total | 20,000.00 | 19,861.54 | 138.46 |
| 50. | Consumables | | | |
| 51. | Office supplies | 5,000.00 | 5,647.19 | -647.19 |
| 52. | Spare parts | 1,500.00 | 1,622.04 | -122.04 |
| 53. | Utilities | 2,300.00 | 2,026.44 | 273.56 |

| | | | | |
|---|---|---|---|---|
| 59. | Component total | 8,800.00 | 9,295.67 | -495.67 |
| 60. | MISCELLANEOUS ITEMS | | | |
| 61. | Organizing internal workshop & seminars | 2,000.00 | 1,961.83 | 38.17 |
| 69. | Component total | 2,000.00 | 1,961.83 | 38.17 |
| | Total | 350,200.00 | 345,779.56 | 112.35 |

### 4.3. Project monitoring and documentation

Good management of the project depended on the regular inflow of information that enabled the Project Manager to have a clear picture of progress at all time. The only way the Project Manager could have the necessary information to carry out his function in an adequate way was to continuously monitor the project's implementation. Eight technical meetings were held throughout the project period.

Another important aspect related to the project monitoring is that the information provided must come in a systematic and standard format in order to facilitate documentation. The huge quantities of reports coming in, without proper formats, would have been as useless as none at all. Therefore, a guideline was produced to make task of report-writing less time-consuming, especially when a few reports were to be submitted at almost the same time. For information entry into the CAIMS, these standards facilitated better integration with reports from individual or multiple authors into the system.

### 4.4 Use of satellite imagery

For many areas, the aerial photographs available at the SFD were outdated. Consequently, more time had to be spent on field assessments and aerial surveys by helicopter. During the course of project implementation, the use of high-resolution satellite imagery (5 m or less) was found to be particularly useful for vegetation interpretation, mapping and planning field surveys. However, the budget allocated for the purchase of satellite imagery was small. And since such items are costly, the project was only able to acquire 4 images. The availability of more current and high-resolution imagery would have certainly accelerated the progress of field surveys. The advantage of using satellite imagery is that the spectral signatures of digital data can be manipulated digitally to extract additional information that is not easily done with aerial photographs. Satellite imagery is also easily geo-coded with real world coordinates, so interpretation produced less errors with regard to spatial accuracy.

### 4.5 Sustainability of Project

Field assessments were completed for 72 of the 105 CA selected at the onset of the project. Therefore, field assessments will have to continue beyond the ITTO-supported project period for the remaining CA. Other sources of funding have already been identified for this purpose.

The CA covered by the project did not include other areas serving similar functions, such as State Parks, Wildlife Reserves and areas designated for the conservation within production forests. In order to have a more complete picture of forest conservation in Sabah, the PSC agreed that these areas be included in the CAIMS. This endeavour will involve collaboration with other government agencies, as well as certain private companies.

The maintenance of the CAIMS is expected to become a routine activity of the SFD beyond the project phase, and therefore, it will be continuously updated as new information becomes available. It will serve as a tool to monitor the status of forest conservation in Sabah.

# 5. PROJECT RESULTS

## 5.1 Achievements of specific objectives

*a) The establishment of an information an monitoring system of conservation areas*

The design and development of a computer-based information system for conservation areas was completed in the first year of the project. This information system is now officially known as the Conservation Area Information & Monitoring System, or CAIMS in short (Appendix C). The CAIMS provides a profile of each CA, including information such as vegetation type and quality, access, size, location, management, history, etc. the conservation area information is also linked to other relevant information such as vegetation classifications, information on soil associations, soil maps of CA, climatic information for selected meteorological stations, areas affected by major fire events, hydrology, forest ecology, geology and socio-economics. The CAIMS will potentially serve as a one-stop centre for information related to forest conservation, thus making such information more easily and readily accessible.

*b) Survey of conservation areas*

In total, 105 CA were identified for assessment under the project. At the end of the project period, field assessments were completed for 72 CA, about 63 % of the total number of CA targeted by the project (Appendix A). However, in terms of area size, the project actually covered 75% of the total targeted area. The project focussed on the larger and more prominent CA like Maliau Basin, Tawai, Bidu Bidu, Imbak and Danum Valley. Field assessments took longer than expected, and will continue beyond the ITTO-supported project phase.

*c) Publication and dissemination of results*

In the Project Document, the method of disseminating information was originally intended to be a book-based publication. However, the 2nd PSC meeting decided that CAIMS be published and made available on the SFD website (www.sabah.gov.my/htan_caims). This makes information on CA more easily and readily available to all interested parties. This form of information also promotes greater transparency in forest management. Another advantage of on-line digital information over a hardcopy publication is that it allows information to be up-dated continuously at little cost.

The CAIMS website was launched officially by the Governor of Sabah in conjunction with the state-level World Forestry Day celebrations on the 24th March 2003. On the 26th April 2003, a presentation of the CAIMS was conducted during the official opening of the new Sandakan Herbarium building, located at the FRC in Sepilok. The presentation was held for the Federal Minister of Primary Industries and other VIP guests.

During the course of the project, two papers were presented to inform relevant parties of Project PD 3/99 and the CAIMS:

- G.H. Petol and R.C. Ong (2001). 'ASCAS Project: Exploring new opportunities for RS Applications'. An information paper presented at the Technical Workshop on New Remote Sensing Methodology for ITTO Project PD 60/99 Rev. 1 (F), 'Optimum Utilization of RADARSAT-SAR Data in Conjunction with Enhanced FCD Model to Monitor Change in the Status of Forest Resources', Jakarta, Indonesia. March 6-7 2003.

- G.H. Petol and R.C. Ong (2001). The 'Assessment of the Status of Conservation Areas in Sabah': An ITTO-supported SFD Project. A paper presented at the 13th Malaysian Forestry Conference, Johore Bahru, Malaysia.

As part of the project activities, two seminars were held in Kota Kinabalu, Sabah, to introduce the CAIMS to potential users. The first seminar was organised on the 20th March 2003 for SFD District Forest Officers. The second seminar was organised on the 22nd August 2003 for key government departments and agencies (i.e. Environmental Protection Department, Wildlife Department, Sabah Parks and WWF Malaysia).


The chairman of the Project Technical Committee, Mr. Frederick Kugan, addressing participants of a workshop on the CAIMS and the role of the District Foresters.

Group photograph of the workshop participants

The Project Manager, Mr Robert Ong (right, chequered shirt) demonstrating the CAIMS to key government officials at a seminar held at the Environmental Protection Department's office in October 2003.

## 5.2 Impact on target beneficiaries

Apart from the SFD itself as the main project beneficiary, other key target beneficiaries of the project include:

- Government agencies such as the Wildlife Department, Environmental Protection Department, and the State Parks,
- Forest Concessionaires,
- Institutes of higher learning, i.e. universities.
- Conservation-related NGOs, e.g. WWF and Malayan Nature Society.

During a discussion meeting in October 2003, all target beneficiaries present expressed support and willingness to contribute towards the further development and maintenance of the CAIMS as a one-stop information centre for all conservation areas in Sabah. It was suggested during the meeting that a technical committee comprising key government agencies be formed to coordinate development of the CAIMS. All appreciate the potential value of the CAIMS in the preparation of Environmental Impact Assessments and Forest Management Plans, apart from promoting greater transparency in forest management by making information available on-line. Thus far, the project has identified 3 conservation areas as priority areas for the formulation of management plans and development. The results of field surveys carried out under the project will form a good basis for drawing up these management plans.

## 5.3 Other beneficial outcomes

The project generated other beneficial outcomes. These were as follows:

*a) New colour scheme for the soil association map*

The soil association map of the early 1970s is a very important landuse planning tool because soils greatly influence the forest that grow on them. The original soils map of Sabah showed 51 soil associations under 7 groups: soil associations on alluvium, mudstone/sandstone, limestone, acid igneous rocks, intermediate igneous rocks, basic igneous rocks and ultrabasic igneous rocks. However, the map had too many colors and it was very difficult to differentiate between soil association and their groups. The map was digitized and a new color scheme was designed based on the main soil groups. Fewer colors, contrasting shades and thatching were also used. The new map now serves as an important reference by the SFD. Soil association maps of the CA are also available in the CAIMS. In the past, soils information for Sabah was not easily available because it only existed as hardcopies and only a few copies were available in print.

*b) Natural vegetation map*

A map of Sabah's natural vegetation was generated from the results of project field assessment data by extrapolating from information on soil association, topography and historical forest inventory. Such a map would be essential for evaluating the status of forest conservation in Sabah.

*c) Vegetation classification scheme*

The only maps available on the natural vegetation of Sabah were outdated maps generated from a state-wide forest inventory carried out in the early 1970s. These maps generally classified forests according to timber stocking, and therefore, do not convey much ecological information. This method is not very helpful for conservation planning purposes. Therefore, the project developed a new vegetation scheme for targeted CA. This new scheme has a stronger ecological basis that takes into account floristic differences, as well as soil and altitudinal factors. (See Appendix B).

*d) Current vegetation cover map*

With the experienced gained by producing maps of CA, the development towards producing a current vegetation cover map was a natural step as satellite imagery obtained during the course of project implementation covered a large part of Sabah. This effort is on-going and the map is expected to be completed by the third quarter of 2004.

*e) Improvement of GIS and remote sensing capabilities*

Six GIS and remote-sensing courses were conducted by the project in order to develop and upgrade the skills of relevant project staff. These courses were as follows:

- Basics of ArcInfo and ArcView (2 courses)
- Intermediate ArcInfo and ArcView
- Analysis using ArcView Image Analysis Extension
- Introduction to ERDAS Imagine
- Aerial photo interpretation

A GIS/remote sensing (RS) facility was also set up at FRC to support the project activities. This facility has now become a permanent feature on the Centre. A full-time GIS/RS specialist was recruited by the SFD in the 3rd year of the project to run the facility full-time.

An operational GIS/remote-sensing lab was set up at the Forest Research Centre to make full use of the knowledge and experience gained during implementation of Project PD 3/99. A specialist was employed and is currently part of a team to continue work based on this project's objectives.

*f) Participation in ITTO Project PD 60/99 Rev. 1 (F).*

In July 2002, a field test was organised for ITTO Project PD 60/99 in the Telupid District, Sabah. The group from JOFCA consisted of:

- Team Leader Mr. Miyatake Susumu,
- Project Officer Mr. Hiroyuki Chiba,
- FCD Mapper designer and RS expert Dr. Atsushi Rikimaru, and
- Malaysian Core Group member Dr. Khali Aziz Hamzah.

The SFD project officers who took part in the field test organised visits to various vegetation types such as primary forest, logged-over forest, oil palm estates and orchards. A minimum of two transects per vegetation type were made assessed in terms of vegetation and crown cover percentage. The SFD officers also contributed ideas and comments to Dr. Rikimaru on the capabilities of the FCD Mapper Ver. 1. One of the major outcomes of the field test was the remodelling of the vegetation density model used in the FCD Mapper program. The current version, the FCD Mapper Ver. 2, is now more accurate in delineating vegetation cover due to the improved Multi Vegetation Density Model.

*g) Opportunities for botanical collecting.*

Field assessments presented researchers from the SFD with good opportunities to collect botanical specimens from all the CA concerned. These specimens from all the CA concerned. These specimens were deposited at the SFD's herbarium at the FRC, Sandakan. Several new records and possibly new species were amongst the many specimens collected during field assessments. Life specimens were also collected for the department's Arboretum in Sandakan.

### 5.4 Project sustainability

The maintenance of the CAIMS that was developed by the project will now become a routine function of the SFD; therefore, it will be continuously updated as new information becomes available. In this respect, the sustainability of the project can be safely assumed. The regular monitoring of CA will be the responsibility of the District Forest Officers concern, and any new information will be conveyed to the manager of the CAIMS.

It was recommended by the PSC that the project scope be expanded to include other conservation areas apart from those targeted under the project. This idea was also brought to the attention of the key government agencies concerned with the management of conservation areas, e.g. the State Parks, the Sabah Foundation, and the Wildlife Department. These agencies have all expressed willingness to contribute towards the further development and maintenance of the CAIMS as a one-stop information centre for all conservation areas in Sabah. Consequently, the project can look forward to closer collaborative links with other government agencies beyond the ITTO-supported project phase. The importance of quick and easy access to current information as provided by the system is recognized by all relevant parties.

## 6. SYNTHESIS OF THE ANALYSIS

| | |
|---|---|
| a) Specific Objective(s) Achievement | |
| i) To establish of an information and monitoring system of the CA. | Realised |
| ii) To carry out surveys of the CA. | Realised |
| iii) To publish the results of the assessment. | Realised |
| b) Outputs | |
| i) The establishment an information and monitoring system of the CA. | Realised |
| ii) Vegetation surveys of the CA. | Partly realised |
| iii) Publication and dissemination of the results. | Realised |
| c) Schedule | Delayed, not seriously |
| d) Actual Expenditures | As planned. |
| e) Potential for replication potential | Significant |
| f) Potential for scaling-up | High potential |

# PART III: CONCLUSIONS AND RECOMMENDATIONS

## 1 CONCLUSIONS

Overall, the project can be considered a successful one. The specific objectives were generally accomplished and the project received encouraging support from all target beneficiaries. Such a project has great potential for replication and scaling up. As such, the PSC recommended the expansion of the project scope to include other CA. Therefore, project activities will continue beyond the recently completed ITTO-supported phase.

### 1.1 Development Lessons

*a) Organization's capacity*

With regard to project implementation, the SFD had the professional and technical capacity and did not require and substantial contributions from outside the department. Since the project was basically technical in nature, its implementation was relatively straight-forward. The decision to restrict the focus of the project to 3 classes of CA within Sabah's PFE was made taking into account the SFD's present staff strength and technical capacity. However, it was subsequently realized that certain staff members of the department could not fully commit to the project implementation due to other job responsibilities. This situation hampered the project's progress to some extent. Therefore, it is important to identify such limitations prior to project implementation.

*b) Interagency collaboration*

The merit of expending the scope of the project to include other conservation areas apart from those targeted under the project was recognized from the beginning. This would have invariably required a bigger budget and the active participation of other relevant government agencies, such as the Wildlife Department and State Parks. Therefore, the SFD foresaw the necessity to continue the project activities beyond the ITTO-supported phase with an expanded scope and other sources of funding. As such, the recently completed project can be considered as an exploratory and development phase towards a fully operational procedure for assessing and monitoring conservation areas in the state of Sabah. As a follow up to the project, the SFD intends to establish more formal collaborative links with other government agencies as soon as possible. The experience from the project puts the SFD at a better position to assist other agencies in carrying out the necessary field assessments.

### 1.2 Operational Lessons

*a) Project organisation and management*

The project implementation was overseen by a PSC and the technical aspects were addressed by a PTC. The bulk of project activities (ground surveys, field reports, project documentation, monitoring of progress, collation of information, etc.) were carried out by the Project Manager and project officers based at the FRC. The GIS and Cartography Sections at the SFD Headquarters provided mapping and remote-sensing services. This arrangement was very practical and there was no need to alter it during implementation. Implementation of the project was straightforward as the professional and technical personnel had the necessary expertise and experience. Therefore, the technical risks involved in project implementation were minimal and posed no major obstacles.

*b) Project monitoring and evaluation*

Good monitoring of the project depended on the ability of the Project Manager to have a clear picture of the progress made in achieving the desired activities as prescribed in the Yearly Plan of Operations. Project officers were required to constantly communicate with the Project Manager on

their progress and submit monthly reports. Throughout the project period, 3 PSC and 8 technical committee meetings were held to discuss progress.

*c) Project documentation*

Due to the large number of reports and information that needed compilation and proper documentation, it was absolutely necessary to assign a capable officer the full-time responsibility of carrying out this task. Field reports had to be submitted in a standard format in order to facilitate documentation. Project documentation was continuously updated and made available on-line through the SFD's website.

*d) Project duration*

After the first year of project implementation, it was realised that a three-year period was not sufficient to assess all the 105 CA targeted under the project. This was because field assessments took longer than expected. A six-month extension period was approved by ITTO to offset this delay.

*e) GIS and remote-sensing support*

High-resolution satellite imagery (5 m or less) and aerial photographs were extremely important for mapping vegetation and planning field assessments. Such items are costly and the project budget allowed for their purchase was relatively small. For many areas, the photographs available were outdated. Consequently, more time had to be spent on field assessments and aerial surveys by helicopter. The availability of more current and high-resolution imagery would have certainly accelerated progress of project implementation.

## 2 RECOMMENDATIONS FOR FUTURE PROJECTS

In order to improve the effectiveness and efficiency of future projects of similar nature, the following recommendations are made:

*a) Project scope and staff capacity*

It is extremely important that the scope of the project be defined such that it takes in account the relevant project members commitments to existing projects and other departmental duties. This is necessary to ensure greater focus on the project by the relevant staff members. In the same way, the implementing agency should also assess commitments of collaborating agencies to existing projects.

*b) Inter-agency collaboration*

If the involvement of other agencies is needed, sufficient funds should be made available for their participation. Another alternative is to involve the prospective collaborating agencies in the project planning process so that they may take necessary actions to procure complementary funding for their participation.

*c) GIS and remote-sensing support*

The use of high-resolution satellite imagery proved very useful for vegetation assessments and mapping. Therefore, its use should be maximised. Future projects should ensure that sufficient funds are allocated for the purchase of satellite imagery. Since the acquisition of high-quality (i.e. cloud-free) imagery may take time, orders for their purchases should be made early in the project. Projects should also ensure that the full-time support of competent GIS and remote-sensing services is made available.

*d) Aerial surveys*

Aerial surveys by helicopter were also found to be extremely useful for vegetation assessments, especially for large forest areas where access to certain remote areas may be difficult. Aerial surveys help especially when old photographs were used in producing vegetation maps and field verification is necessary to confirm the status of vegetation conditions. Aerial surveys also reduce the time needed for ground inventory.

*e) Payment of honoraria*

Payment of honoraria to key project staff does ensure greater commitment to project activities. Therefore, future projects should continue to provide such financial incentives, even if the amount is minimal.

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Responsible for the Report

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Name: Daniel K S Khiong
Position held: Director of Sabah Forestry Department,
Chairman of Project Steering Committee, Project PD 3/99
Date: 7th March 2004

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## APPENDIX A: List of conservation areas available in the CAIMS.

| Class I | | Class III* | | Class IV | | Class VI | |
|---|---|---|---|---|---|---|---|
| Forest Reserve | Area (ha) | Forest Reserve | Area (ha) | Forest Reserve | Area (ha) | Forest Reserve | Area (ha) |
| Balembangan | 371 | Jembongan | 1,582 | Kg. Hindian | 580 | Crocker Range | 3,279 |
| Bengkoka | 6,270 | Kawang | 1,551 | Nabahan | 356 | Garinono | 451 |
| Bidu-Bidu | 16,094 | Labuan | 199 | Padas Damit | 9,027 | Kabili-Sepilok | 4,294 |
| Binsuluk | 12,106 | Lema'as | 1,482 | Ulu Kukut | 1,297 | Karakit | 24 |
| Botitian | 2,145 | Matunggong | 328 | | | Keruak | 1,816 |
| Bkt. Taviu | 8,630 | Tagaroh | 1,592 | | | Labuk | 120 |
| Bkt. Kuamas | 7,324 | Tamparuli | 60 | | | Kitabu | 200 |
| Danum Valley | 43,800 | Tajong | 436 | | | Lajong | 300 |
| Kelawat | 201 | Tatahan | 17 | | | Loro | 471 |
| Klias | 3,630 | Tamalang | 108 | | | Maligan | 9,240 |
| Lamag | 2,133 | | | | | Materis | 1,816 |
| Leila | 302 | | | | | Milian-Labau | 2,712 |
| Limau-Limauan | 223 | | | | | Pangi | 1,816 |
| Lipaso | 3,866 | | | | | Rafflesia | 356 |
| Maliau Basin | 59,000 | | | | | Sepilok | 1,235 |
| Mandamai | 5,330 | | | | | Sungai Lokan | 1,852 |
| Mt. Cochrane | 2,924 | | | | | Sungai Paitan | 129 |
| Mt. Pock | 11,585 | | | | | Sungai Sapi | 625 |
| Mt. Walker | 149 | | | | | Teak Plantation | 3 |
| Selangan Is. | 120 | | | | | Ulu Sapa Payau | 720 |
| Sosopodon | 11 | | | | | | |
| Tambalugu | 197 | | | | | | |
| Tawai | 22,697 | | | | | | |
| Tenompok | 1,984 | | | | | | |
| Ulu Telupid | 7,508 | | | | | | |
| Total | 25 | Total | 10 | Total | 4 | Total | 20 |
| Total hectarage | 212,000 | Total hectarage | 7,355 | Total hectarage | 11260 | Total hectarage | 31,459 |

Total number of Conservation Areas assessed = 72

Total number of Conservation Areas included in the CAIMS = 59

* Class III Domestic Forest Reserves were also assessed in this project.

# APPENDIX B: Classification of vegetation cover developed and used by Project PD 3/99.

## 1. Cultivated Vegetation

Definition

Crops cultivated for agricultural or forestry purposes, usually in the form of monoculture.

### 1.1 Non–tree crops

Main non-tree crops to be interpreted from remote-sensed images:

- Oil palm
- Coconut
- Wet paddy
- Other non-tree crops (if land area cover more than 250 ha, specify crop)

Additional information:

- Other non-tree crops include pineapple, sugarcane, corn, banana, papaya, tapioca, etc.
- If the cultivated area consists of single type non-tree crops, and is less than 250 ha, the area should be labelled as *Other non-tree crops*.
- If the cultivated area of a non-tree crop is more than 250 ha, the area should be labelled with the type of crop.
- If the main crop (for example, oil palm, coconut or wet paddy) is interspersed with other crops, as in intercropping plantations, specify the other crops.

### 1.2 Tree crops

Main tree crops to be interpreted from remote-sensed images:

- Rubber
- Tea
- Coffee
- Cocoa
- Planted forest
- Other tree crops (if land area covers more than 250 ha, specify crop)

Additional Information

- Other tree crops include tobacco, durian, mango, etc.
- If the cultivated area consists of single or mixed tree crops, and is less than 250 ha, the area should just be labelled as *Other tree crops* (note plural form of crop).
- If the cultivated area of a tree crop is more than 250 ha, the area should be labelled with the type of crop.
- If the main crop (for example, rubber, cocoa or planted forest) is interspersed with other crops, as in intercropping plantations, specify the other crops.

### 1.3. Mixed crops

Cultivated areas where there are many different crops and no single crop area is significant enough to be delineated.

## 2. Natural Vegetation

Definition

Indigenous vegetation in primary or old growth form, or disturbed forest where the original species composition still accounts for *at least* 30% of the basal area.

(Note: When delineation of such forest is by using remote-sensed images, it is assumed that crown projection of original species is correlated to basal area. Only proper forest inventory can verify this assumption.)

2.1 Subalpine forest—forest occurring over 3500 m asl.

2.2 Montane forest—forest occurring at 1000–2500 m asl.

- Lower montane (1000 to 2500 m asl)
- Upper montane (2500 to 3500 m asl)

Note: The elevation above sea level where this forest begins differs from one mountain to another. The clearly recognizable altitudinal zonation in Peninsula Malaysia is obscured in Sabah and Sarawak.

2.3 Dipterocarp forest—forest where the Dipterocarpaceae is the most dominant family in terms in basal area.

- Upland dipterocarp (500 to 1000 m asl)
- Lowland dipterocarp (<500 m asl)

Note: The elevation above sea level where this forest begins differs from one mountain to another. The clearly recognizable altitudinal zonation in Peninsula Malaysia is obscured in Sabah and Sarawak.

2.4 Kerangas forest—forest occurring on coarse silicaceous deposits, giving rise to podzolic soils.

- Montane kerangas (>1000 m asl)
- Upland kerangas (500 to 1000 m asl)
- Lowland kerangas (<500 m asl)

Note: The elevation above sea level where this forest begins differs from one mountain to another. The clearly recognizable altitudinal zonation in Peninsula Malaysia is obscured in Sabah and Sarawak.

2.5 Tidal forest—coastal and estuarine forests that are influenced by tidal levels.

- Mangrove—tidal forests where the genera *Rhizophora*, *Bruguiera* and *Avicennia* are most common.
- Nipah—brackish water vegetation dominated by nipah palms.
- Transitional—forest occurring between mangrove and dryland forests.

2.6 Swamp forest

- Peatswamp forest—forest occurring on peaty wetlands.
- Seasonal swamp forest—forest occurring on seasonally flooded areas.

2.7 Limestone forest—forest occurring on limestone outcrops.

2.8 Beach forest—coastal forest occurring on sandy beaches or rocky shores.

## 3. Secondary Vegetation

Definition

Forests or vegetation established naturally after a dramatic disturbance (e.g. clear-felling, poor timber harvesting techniques, landslides, fire, etc.) where secondary species composition accounts for *more than* 70% of the basal area.

(Note: When delineation of such forest is by using remote-sensed images, it is assumed that crown projection of secondary species is correlated to basal area. Only proper forest inventory can verify this assumption.)

3.1 Secondary forest—forest composed principally of secondary tree species.

- Secondary forest (MDF)—secondary forest growing on areas formerly supporting mixed dipterocarp forest.
- Secondary forest (ultramafic)—secondary forest growing on areas formerly supporting ultramafic forest.
- Secondary forest (kerangas)—secondary forest growing on areas formerly supporting kerangas forest.
- Secondary forest (limestone)—secondary forest growing on areas formerly supporting limestone forest.

3.2 Grassland/barrenland—area principally covered with grass, e.g. lalang grasslands.

3.3. Scrub—area principally covered with scrubs not exceeding 4 m in height.

3.4 Herbaceous swamp—herbaceous vegetation on areas formerly supporting swamp forests.

# APPENDIX C: Guide to using the CAIMS

This is a pictorial guide to using the CAIMS. General text is black in colour and instructions are in blue.

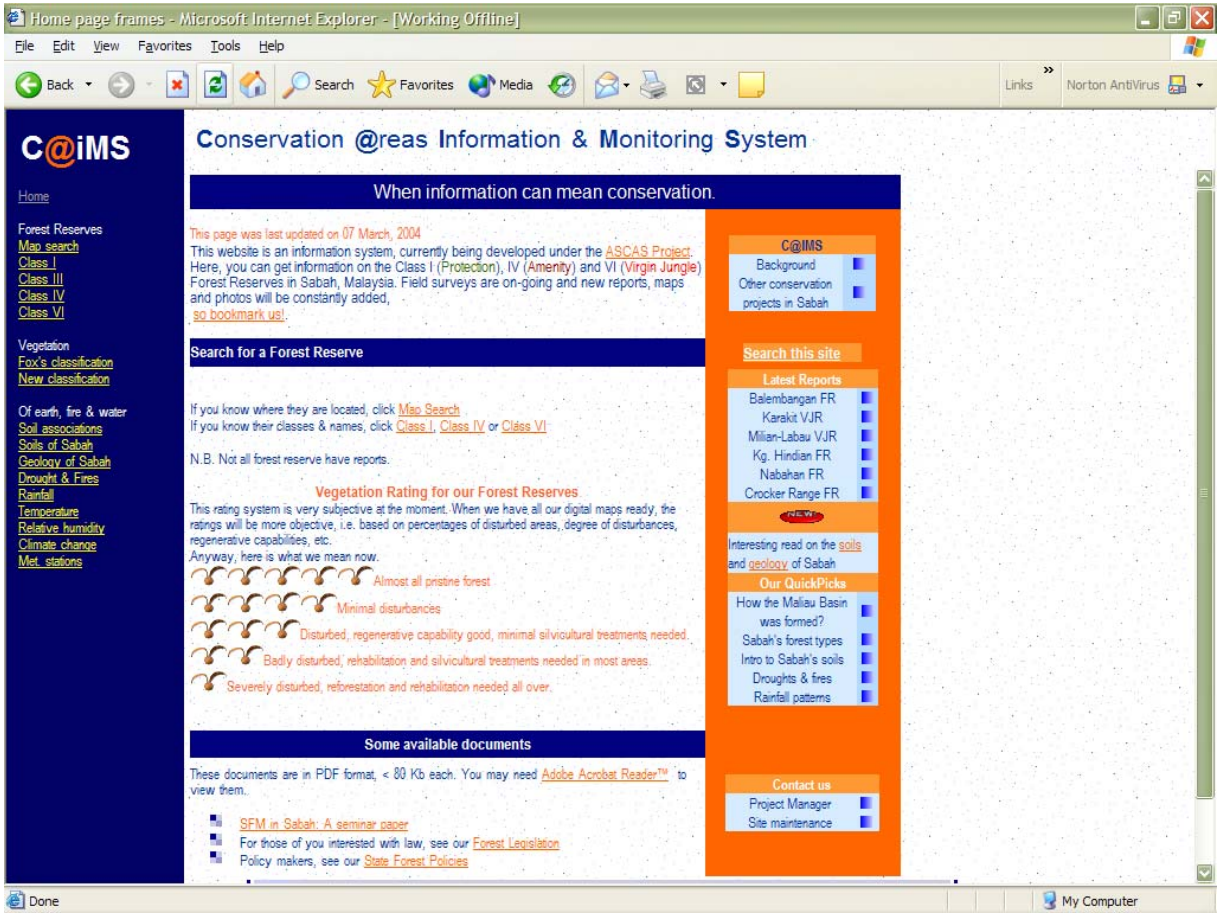
This is the main page of the CAIMS.

Main menu is on the left (blue background).
Under the group **Forest Reserves**, you can search for forest reserve reports by clicking on the links.

- If you know where the forest reserve is situated, click on Map search.
- If you know the name and class of the forest reserve, click on the **Class I**, **Class III**, **Class IV** or **Class VI** links.

Other relevant information is under **Vegetation** and **Of earth, fire & water** groups.

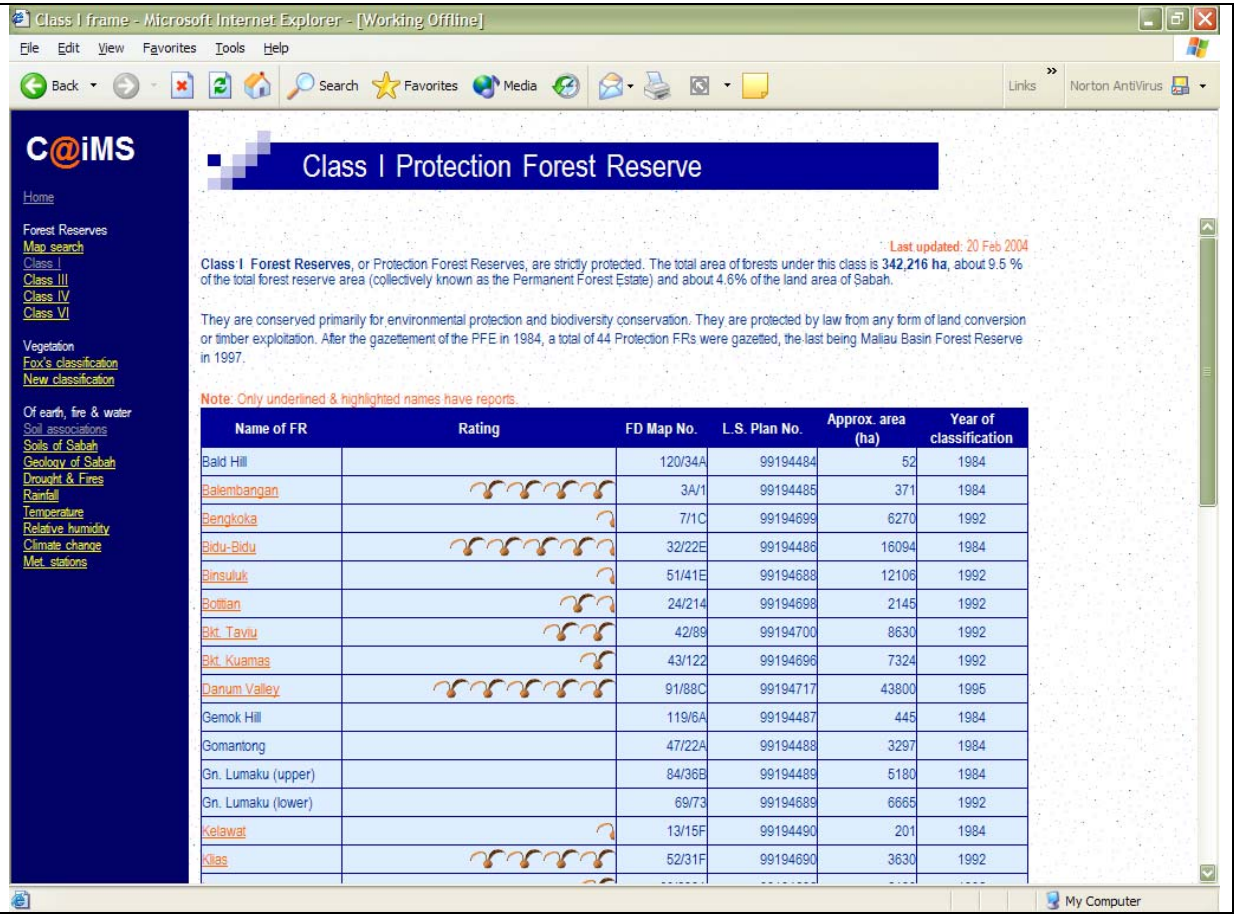
- Click the **Class I** link to go to the Class I page.



Class I main page

This is the Class I page. The forest reserves are arranged in alphabetical order. Only highlighted names have reports. The second column shows the vegetation status rating of the forest reserves (higher number relates to better forests).

- Click the Danum Valley link in the first column to go to the report.

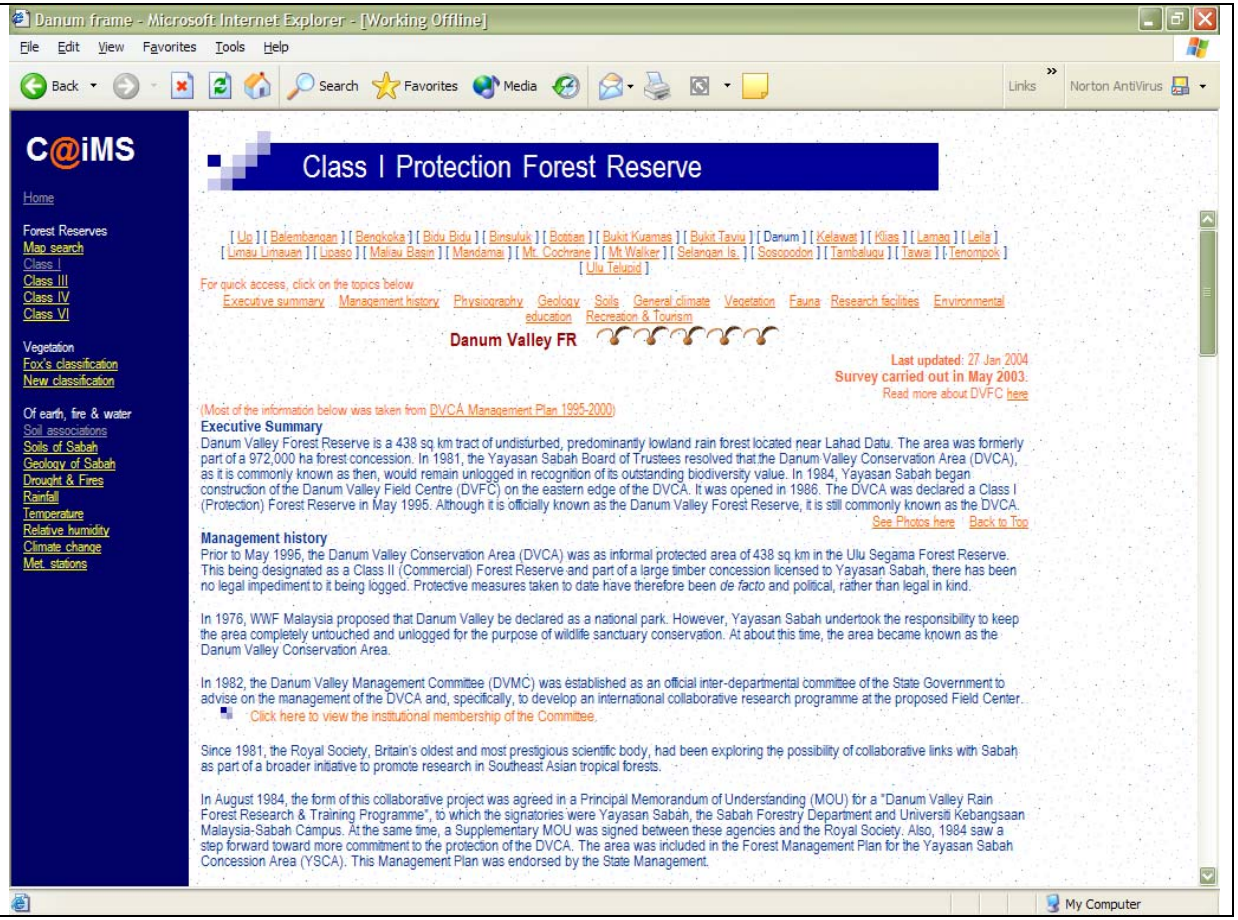


Danum Valley FR page

This is the Danum Valley FR page. All forest reserves pages look similar to this page. This first set of links on the top is to other Class I forest reserves. Immediately below are the links to the main subjects covered in the page. For quicker access, click on these links.

There are other links on the right-hand side of the page that leads to pages that provide additional information.

- Click the Soils link to read about the soils in Danum Valley.

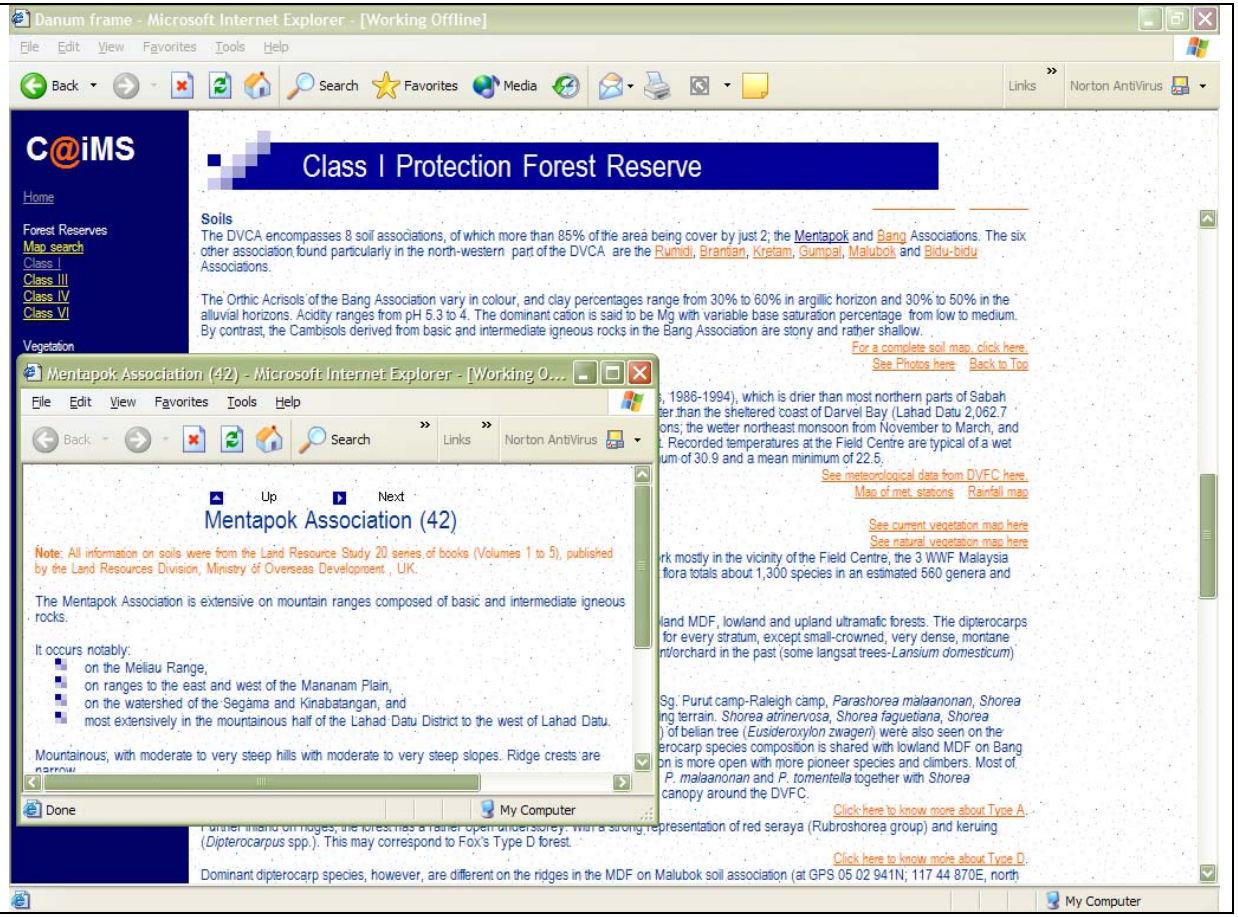


Information on soil associations

This is the information on the Soils of Danum Valley FR. The highlighted and underlined names are name of soil associations. Click any one to read more on the soil association. A new window will be opened. Close the window after reading the contents.

Below the second paragraph on the right, there is a link to the soil map of Danum Valley.

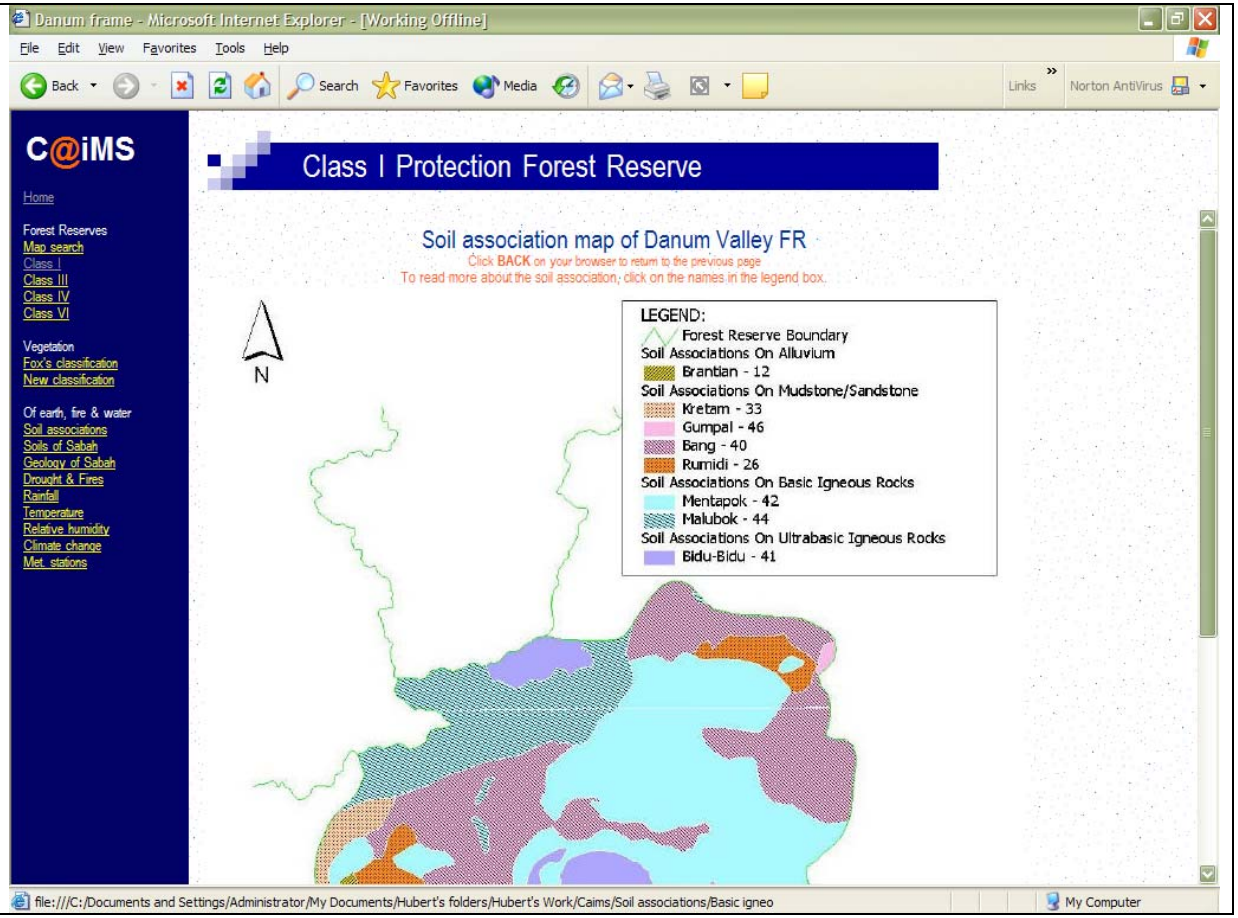
- Click on the For complete soil map, click here link.



Soil association map of Danum Valley FR

This is the soil association map of Danum Valley FR. To read more on soil association, click on the names in the legend box. A new window, similar to the one previously, will open.

- Click BACK on your browser to return to the Danum Valley page.



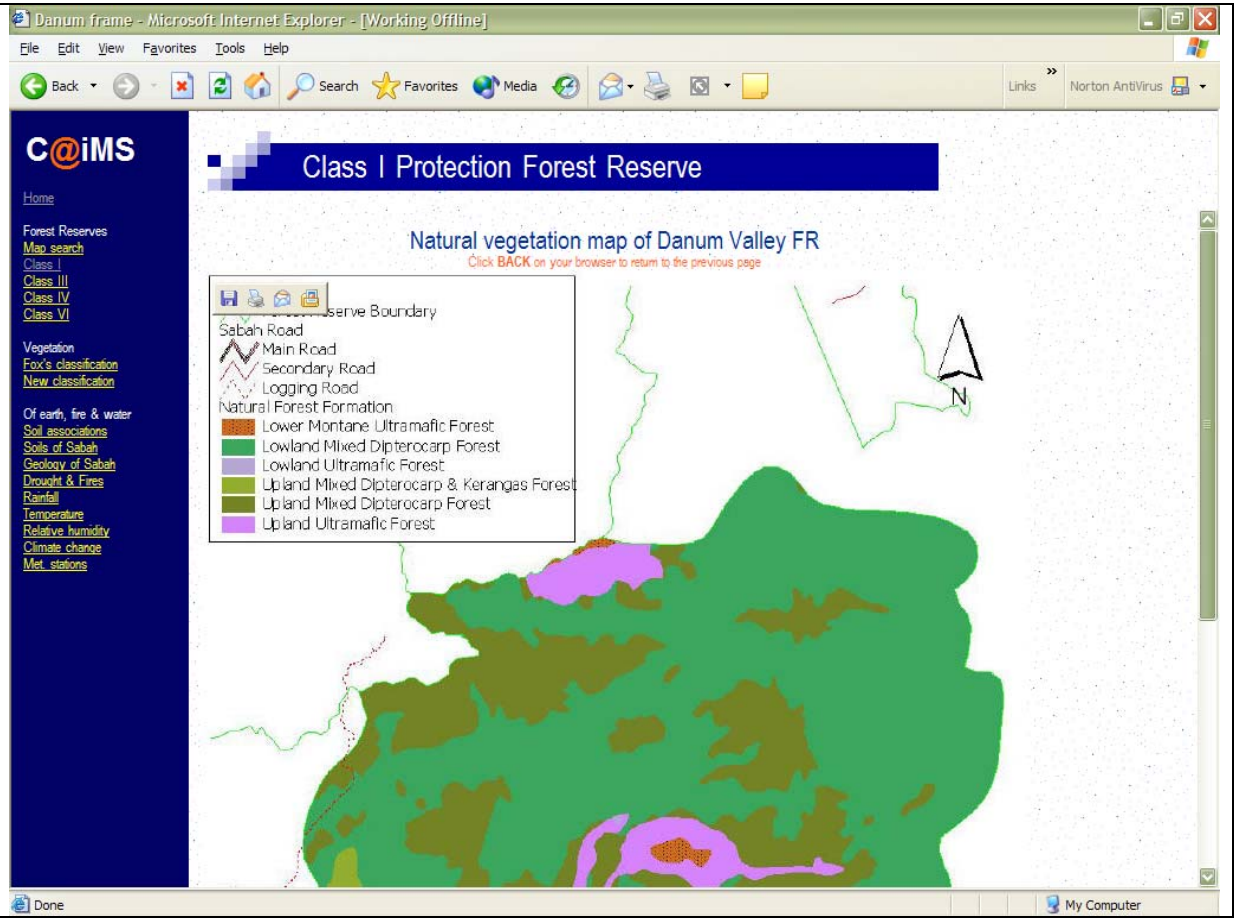
Natural vegetation map of Danum Valley FR

The third subject is on Vegetation. On the right is a link to the natural vegetation map of the forest reserve.

- Click on the See natural vegetation map here link.

This is the natural vegetation map of Danum Valley FR.

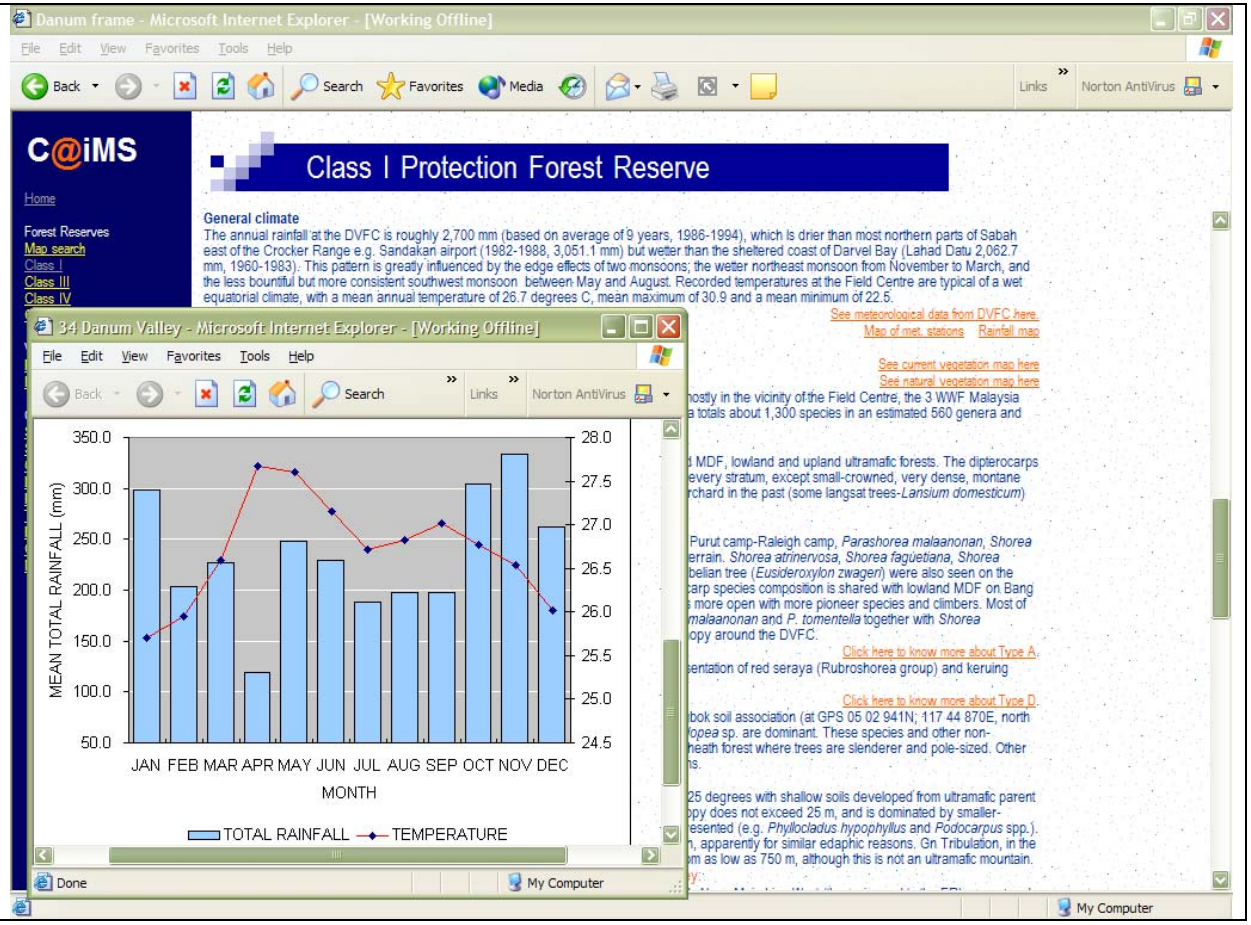
- Click BACK on your browser to return to the Danum Valley page.



Meteorological data for Danum Valley FR

- Go to the section on General climate.
- Click on the See meteorological data from DVFC link.

The new window shows rainfall and temperature (if available) levels on yearly and monthly graphs.



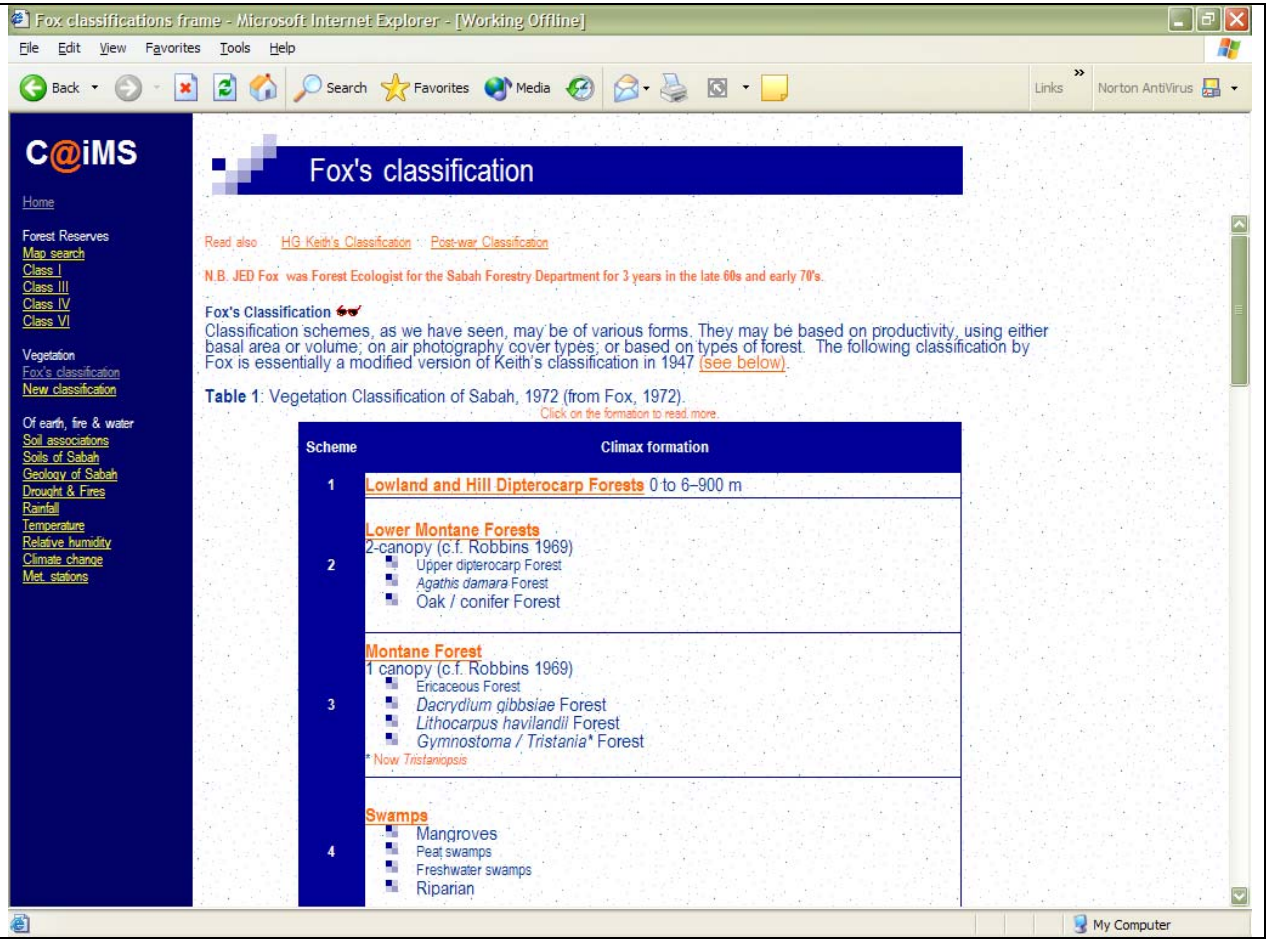
Other information

Click HOME on the left-hand menu bar.

- Under Vegetation, click on Fox's classification.

This vegetation classification was introduced in 1972 and is an important reference for Sabah's vegetation.

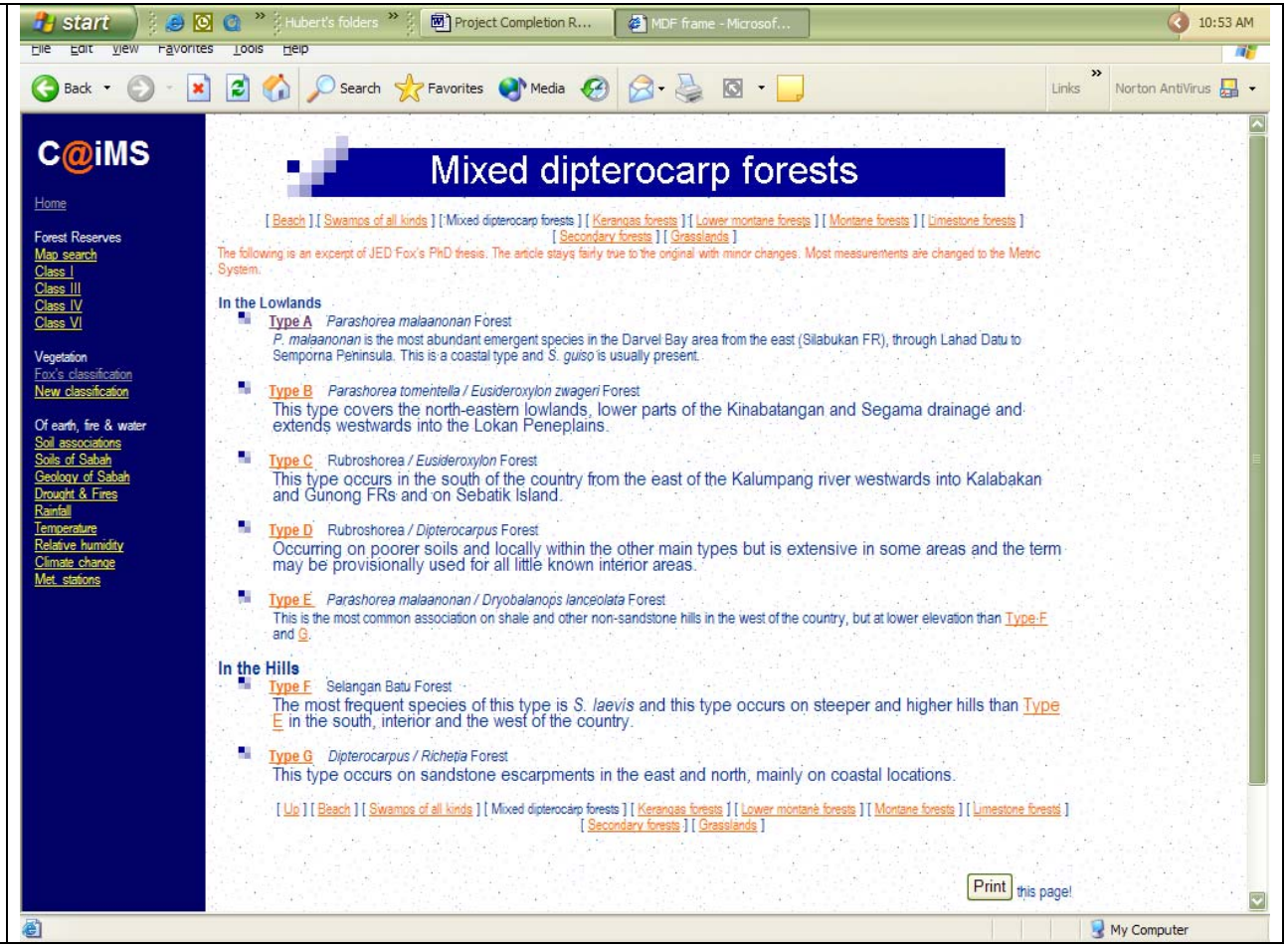
- Click on Scheme 1, Lowland and Hill Dipterocarp forests.



Information on mixed dipterocarp forests.

This page provides an overview of 7 types of dipterocarp forests in Sabah.

- Click on Type B.

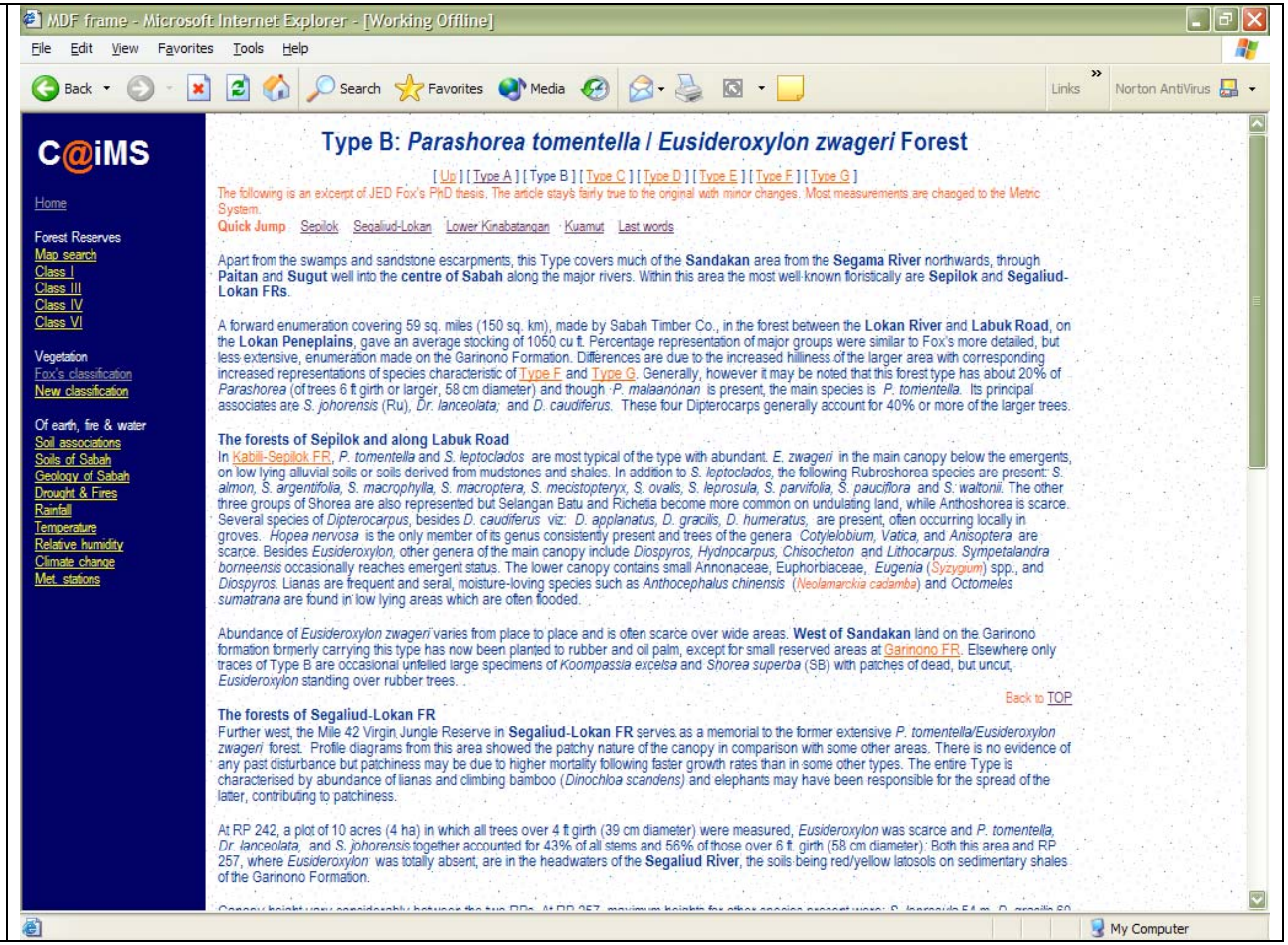


Information on mixed dipterocarp forests.

This page provides an overview of all Type B dipterocarp forest in Sabah.

The text is also linked to other relevant pages, like Kabili-Sepilok FR and Garinono FR in this page.

- Click HOME on the left-hand menu bar.



Other Information.

On the left-hand menu bar, there are links to other information like Geology of Sabah, Droughts & Fires, Rainfall, Climatic information, etc.