CHAPTER 8

SUMMARY, CONCLUSION AND RECOMMENDATION

The purpose of this final chapter is to bring together the results, findings, as well as to summarise the significance of the study undertaken at Sg. Tua FRA. Problems addressed and methods will be briefly mentioned. General summary, conclusion and recommendations are presented.

General Summary

Forest Policy

The purpose of the National Forestry Policy 1978 (Revised 1992) on forest recreation programme is

"To promote education in forestry and undertake publicity and extension services in order to generate better understanding among the community on the multiple values of forests"

More specifically, the implementation strategy for the forest policy will take the form of

"Promoting public awareness in forestry through educating the community to appreciate the functions of forest", and

"Undertaking community forestry programmes to cater for public needs in recreation and tourism".

As such, policy implementation on forest recreation is one of symbiotic dichotomy of affording legal protection to forest recreation, while allowing for recreational use and enjoyment of these values we wish to protect. In this respect, the policy implementation has embodied a vital change in the philosophy of forest management, away from timber production to one of social sustainability of forest uses including recreation. As we are now in the 21 st Century, the dictums of social sustainability of forest uses will assume greater importance particularly of those pertaining to non-timber produce, including recreation.

Site Selection

Forest Recreational Areas in Malaysia have yet to experience the same degree of recreational use, as their counterparts in the developed countries like those in the United States of America, Canada and United Kingdom, or other countries with similar forest recreational values. Nevertheless, there are areas in Selangor, Malaysia especially those FRAs located within the vicinity of the nation's capital, Kuala Lumpur are now experiencing increasing over-crowding (Yap and Noor Azlin, 1990; Benson et al., 1996), rising used levels (Anon, 1992c; Lai and Amat Ramsa, 1993) and possibilities of visitors' conflict (Khalid and Mohd Shahwahid, 1983; Yong, 1995; Noor Azlin, 1999) and, if left unchecked will cause deterioration of the biophysical conditions especially those of soil, vegetation and water quality. This in turn will result in reduced recreational opportunities for visitors to FRAs.

The Sg. Tua FRA astriding the trunk road between Kuala Lumpur and Ulu Yam is well served by public transportation and Forestry Department records (Anon, 1992c; Benson et al., 1996) have shown that this FRA is a popular stop-over point for those who enjoy forest recreation. Similar to most FRAs in the peninsular, Sg. Tua FRA is water based, well drained by Sg. Batu and endowed with abundant and varied ground cover, thereby offering an ideal opportunity to study the effects of forest recreation.

Site Stratification

Study sites are observed to receive different recreational impacts due to their locations in the study area. The effects of the different intensity of recreational use offer support to the use of site stratification based on prior knowledge of recreational use. This approach would not only provide a more equitable distribution of sample sites throughout the study area, but also allow matching of those sites having different degree of habitat wear to different recreational intensity. As such, this approach of site stratification would provide a more superior method of sample selection than those of random selection. Site stratification would also have the advantage of eliminating those sites subjected to obvious transient recreational use.

"After-the-Fact" Analysis

The approach, as applied in the recreational study of Sg. Tua FRA lends support towards "after-the-fact" analysis. Since almost all of the FRA in Peninsular Malaysia has been used at one time or another prior to the area being designated as Forest Recreation Area, it will be impossible to reconstruct the environment minus the effects induced by recreation. Therefore the assumption applied is that the study area is homogenous prior to introduction of recreational use and that differences between impacted sites and adjacent areas can then be directly or indirectly attributed to habitat wear by effects/impacts of forest recreation.

Ideally, the effects of forest recreation should be monitored when the area is first opened for use. Depending on the rate of change of the intensity of recreational use and generally the rate of change of the environment will be slowed. As such, the scale for such investigation will be exceedingly long and costly. Also, by the time of completion of study, the environmental changes due to recreation use may be irreversible further lending support to the use of "after-the-fact" analysis.

Through the use of the "after-the-fact" analysis of attributing habitat wear by recreation on impacted and adjacent areas, data are obtained quickly and relatively cheaply, and results can be used in management decisions for the area in which investigation has taken place. The approach adopted is not new and has been used for studying the physical effects of recreational use by Chappell et al. (1971), Burden and Randerson (1972), Dale and Weaver (1974) and Liddle and Greig-Smith (1975).

Conclusion

As a result of recreational use, changes in the environment are inevitable. Some typical and potential significant impacts from recreational use have been investigated during the Sg. Tua FRA study. Knowledge gained from this study confirm the vulnerability of the environment in terms of soil, vegetation and water quality to various levels of recreational use. Guided by such investigation of impacts on forest recreational use at Sg.Tua FRA, the following conclusions can be drawn.

Soil

From the investigation of forest recreation at Sg. Tua FRA, most significant factors are those activities causing compaction which eventually can lead to a host of other activities such as increased run-offs causing erosion of mineral soil (Wetzeel, 1983; Wetzeel and Likens, 2000), changes in composition of plant community (Liddle and Greig-Smith, 1975), increase in turbidity thereby affecting both water quality (Bruijnzeel and Critchley, 1994) and fish habitats (Douglass, 1990), while excessive erosion can cause breakdown of stream banks (Lai and Amat. Ramsa, 1993).

On the basis of precision and accuracy in determining soil compaction, Gravimetric Method is preferred to those of pocket penetrometer and soil moisture meter. Though labourious, the Gravimetric Method gives better descriptions of soil compaction in terms of bulk density, soil moisture content, total and air-filled pore space.

Compaction causes a shift in pore size, as the primary aggregates are pressed together and rearranged. Owing to persistent compaction (heavily used sites), the walls of many of these primary aggregates (pore voids containing both air and water) are ruptured causing a loss of soil moisture (content) as well as, the resultant decrease in water (infiltration) and air (aeration) permeability due to reduction of macroporosity. Simultaneously, the soil becomes more compacted as it increases in bulk to fill the voids vacated by both air and water, and a corresponding decrease in total and air-filled pore space. These conditions persist with both increasing recreational use, as well as with increasing soil depth.

However it is the upper soil layer (0-10 cm) that readily absorbs most of the compaction stemming from the different recreational use. At the lower soil layer (10-20 cm), the soil is less compacted as reflected by the lower bulk density, higher soil moisture content, and presence of more pore space (both total and air-filled). La Page (1967) and, Liddle and Greig-Smith (1975) have reported similar observations. The former reported that most compaction take place at the top 6 inches of the soil, while the latter noted that bulk density has a linear relationship with recreational use until it reaches a level whereby further compaction does not take place.

The indifference of compaction at the lower soil layer is important, since the increased presence of soil moisture will allow it to act as a lubricant to weaken the adhesive bonds between particulates, and therefore the capillary strength of the soil, which would enable the soil to recharge itself. This ability to recharge itself is extremely crucial during the dry season where such recharges are essential for plant survival.

Guided by the investigation of Sg. Tua FRA, it is evident that soil texture and soil density govern soil compaction. Nevertheless, it is still difficult to select the type of soil, which can best withstand the impact of recreation. In general, more fertile site with low initial density are affected less by recreational use than site with inherent coarse textured soil that are less fertile and low in organic matter.

Vegetation

Maintenance of a vigorous ground cover is probably the most obvious concern of forest managers managing FRAs. However, soil changes quickly following the first use of a new site. A large percentage of the litter cover can be scuffled away during initial use (Frissell and Duncan, 1965). Once this protected layer is removed, the soil surface rapidly becomes compacted (Merriam, 1976). These observations are consistent with the results of the Sg. Tua FRA study.

The analysis proved conclusively that ground cover deteriorates with respect to different intensity of recreational use. At the control site (climax vegetation) ground cover declines rapidly upon opening up for forest recreation. Broad-leafed, succulent species having little resistance to recreational use, quickly give way to the more resistant species at the lightly used sites. Here at the lightly used sites, recreational use selectively favours those suppressed but more resistant species. As a result, the species diversity increases though plant numbers decreases.

Plants at the lightly used sites are beginning to develop morphological modifications in term of leaf-sheath, more prostrate stems instead of leaves and plants having reduced leaf area. These modifications are more pronounced at the medium used sites and culminating in the appearance of tussocks in place of prostrate ground vegetation. At the heavily used site, the recreational impact may have exceeded the ability of the ground to sustain vegetation regeneration and ensuing in bare ground conditions.

The existence of ecotone is denoted by changes in species composition and plant numbers with sharp gradient of wear from impacted sites to forest margin, are most obvious with the heavily used site. However, with control and lightly used sites, the ecotone gradient is fairly constant, showing equal occurrences of plants from impacted sites towards the forest margin, although the plant numbers are less in the case of the lightly used site.

Additional impacts on vegetation may also include damage to trees and shrubs from fire wood collecting at campsites (Yap and Noor Azlin, 1990; Noor Azlin 1999). Not only does this process causes increase in erosion potential by decreasing the amount of organic matter, but also they destroy habitats for various animals and birds (Douglass, 1990).

Water Quality

The analysis of the physical components of forest recreation especially those of soil and vegetation cover and water proved conclusively that differences in intensity of forest recreational use affect soil and vegetation properties, while indifferent to those of water quality. Nevertheless, the protection of water quality would still be one of the inherent goals of FRA management. This is particularly so, since most of the designated FRAs are water-based and as such, are most likely to encompass the headwaters of various rivers. In the case of Sg. Tua FRA, Sg. Batu is its major headwater.

Investigation of recreational use in Sg. Tua FRA confirm that water quality of Sg. Batu is of relatively high standard in terms of temperature, pH, dissolved oxygen, conductance and turbidity. Low water temperature is attributed to shading effects of the forest canopy on water, while water turbulence incur energy absorption thereby contributing to the decline of water temperature. Evaporation loss through heat exchange and the absorption of solar radiation during precipitation, are other important factors causing decline in water temperature, as compared to the surrounding ambient temperatures.

pH values of water at Sg. Batu, are confined to between 6.98-7.12. These are well within the optimal pH range to support biological life. The relief and drainage ratios of 0.27 and 0.54 respectively, may have provided the flushing effects necessary for the advection and dispersion of hydrogen ion throughout the water-body, thereby contributing to the low pH values. Other reasons for the near neutral pH, are the high density root mat and thick litter layer which act as an efficient filter for the overland flow entering Sg. Batu. The filtration process also accounts for the low turbidity values, while the relief ratio of 0.27 accounts for the high conductance readings. In addition, the mean turbidity values of between 4.79 NTU-5.21 NTU are well within the interim standards for Class 1 Water of 5 NTU (Anon, 1986).

Sg. Batu is relatively rich in dissolved oxygen, having a range 6.9 mg/l-7.4 mg/l, which is much higher than the minimal of 5 mg/l of dissolved oxygen required for aquatic life (Anon, 1986).

As such, the waters of Sg. Batu is relatively clean; low water temperature providing a relief to visitors, near neutral pH making the water relatively "safe" for swimming since water being too acid (<pH 6.0) or too alkaline (> pH 8>0) will cause skin irritation to swimmers, turbidity values well within the interim standards of Class 1 Water (Anon, 1986), while high conductance values which are well within the classification for clean water (Anon, 1986). There is also sufficient dissolved oxygen in the waters of Sg. Batu to support aquatic life. Generally, no management action will be required.

Recommendation

The Sg. Tua FRA study has confirmed the occurrence of different environment responses to different intensities of forest recreational use. Such sites though limited in area, are relatively easy to identify on the basis of ground cover variation and some are presently over-used as indicated by the presence of barren ground. Since the area is designated for forest recreation, a certain amount of habitat wear is acceptable and neither is it conceivable for forest managers to maintain such sites in apparently undisturbed condition.

Considerable amounts of barren ground, and increases in soil compaction are indications of over-use causing ecological changes, while water quality remains indifferent to recreational use. When such indications are detected, some form of management is essential to prevent further deterioration.

Management Implication

The presence of different recreational use within Sg. Tua FRA imply the need for different forms of management. As such, a sequence of use-related site changes is developed based upon a set of conditions classes, each with its appropriate and easily visible indicators (lightly, medium and heavily use and control), which will allow the resource manager to quickly classify the sites, compare conditions identify over use areas and suggestions for their management.

Firstly, heavily recreational used sites are severely deteriorated, indicated by a lack of vegetation cover and highly compacted soil. These sites could be removed from use to ensure recovery through natural ecological processes or by management practices, which include artificial regeneration or transplanting, when rapid establishment of plants is desired. Compacted soil can be improved by physical soil treatment such as, amelioration of the upper soil layer by way of soil scarification, while eroded sites can be restored by soil brought in externally. Litter can be redistributed and grasses planted to help to hold it in place.

Other related steps to eliminate overused sites may include site closure and provisions of alternative sites for recreational use to disperse the visitors to other portions of the FRA. Another method is the "sacrifice sites" concept whereby a few areas are "sacrificed" so the rest can remain undisturbed. This may be understandably unpopular. But the decision to sacrifice is made in an attempt to improve the conditions in a few localised sites.

Since the cycle of deterioration and recovery of recreational sites are endless, under a rest and rotation system. A wiser approach is to contain site deterioration in the heavily used sites by applying management techniques to prevent seasonal impacts and use of site hardening ie. hardening of soil surface with asphalt, gravels soil, cement or wood chips.

An even larger management goal is to shrink the heavily used site, especially the barren ground to as small areas as possible, but such techniques are offensive and should be minimised. A more positive management technique would be to design the FRA in such a way to ensure that the visitors are restricted to heavy traffic area through the use of hardened path, toilets, picnic tables.

Secondly, with medium used site, changes to ground surface are noticeable and the vegetation cover are getting thinner interceded with bare ground. Vegetation cover may appear as tussocks linked by numerous prostrating stems. Nevertheless, these visual indicators are linked by the less visible, but more complex changes such as, increasing soil bulk density from soil compaction, lower soil moisture content, poorer aeration and water permeability. At this point, ecological changes have become readily visible to the untrained eye. Visitors notice that the site is different from the surroundings. It still has its "greenness" but in between are the bare ground. Management would take the form of controlled use interceded with soil conditioning to strengthen the site.

Thirdly, it is hard to differentiate the lightly used site with the control site. Lightly used sites actually show increase in species biological diversity, but decrease in plant numbers, as compared to the undisturbed sites. It is possible that control of the level of use could be used to create aesthetically pleasing communities and diversify the vegetation in an otherwise undisturbed habitat. Nevertheless, both sites are well covered with vegetation. These sites are readily identified by visitors presence. Furthermore, recreational use still needs to be monitored to detect adverse changes.

Fourthly, at the control site where vegetation is climax and no management action is needed. Control areas are rarely penetrated by visitors and can also serve as refuge for small animals and birds.

As such, the range of recreational use from control through to lightly, medium and heavily used have provided a continuum starting with a natural community, progressing to semi-natural community and ending at the heavily modified environment.

Fifthly, any management programme clearly must be accompanied by use of education in the practice of forest recreation. This might include information on the strength and fragility of the ecology, sustainable use of the resources within the FRA, and the social responsibility (which may include dos and don'ts) of visitors to FRA.

Sixthly, admittedly management of such nature somewhat inhibits the freedom of choice and movements now available to visitors at the Sg. Tua FRA. But this may be the price the visitors have to pay to ensure sustainable use of the basic resources of the FRA. Nevertheless, there is evidence from the Sg. Tua FRA study that some kind of limitations may be necessary, if the attractions are to be preserved at a desirable level of quality.

Actions to be undertaken will of course depend on the local forest authority and the ecosystem involved. For illustrative purposes, a set of possible management actions has been suggested for sites within each use class. (Appendix 28). With minimal training of personnel and requiring no specialised equipment, this classification scheme and its related management actions, allow almost immediate progress towards preserving a lasting supply of high quality forest recreation areas.

Suggestion For Further Research

Another study of the sample sites is required to determine the changes in biophysical conditions (soil, vegetation and water quality) of Sg. Tua FRA as to determine whether those changes have been stabilised. A comparative study would indicate the rate of change of these biophysical parameters. Based on the premise that degradation of biophysical conditions can lead to a reduction in the aesthetic attractiveness of the site as well as, reduced recreational opportunities available to visitors to FRA, the study would provide the data necessary to sustain the quality of the resources, in relation to the desirability of the various intensities of recreational use or in extreme cases may necessitate periodic closure of some of these recreational sites.