ENVIRONMENTAL SCIENCE, ECOSYSTEMS & DEVELOPMENT

Proceedings of the 5th WSEAS International Conference on ENVIRONMENT, ECOSYSTEMS and DEVELOPMENT (EED'07)

Puerto De La Cruz, Tenerife, Canary Islands, Spain
December 14-16, 2007
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Preface

The book you are currently holding contains the Proceedings of the 5th WSEAS Int. Conf. on ENVIRONMENT, ECOSYSTEMS and DEVELOPMENT (EED'07) which was held in Puerto De La Cruz, Tenerife, Canary Islands, Spain, December 14-16, 2007

Environmental Science and Engineering as well as Environmental Policy is now of fundamental importance to our civilization. Several problems have now become major political issues and the subject of international debate and regulation. It is for this reason that there is a need for conferences dedicated to energy and environment issues. Environment, Ecosystems and Development is an interdisciplinary conference aimed at natural scientists, technologists and the international social science and policy communities covering the direct and indirect environmental impacts of environment, ecology and ecosystems, sustainable development, cultural heritage, energy acquisition, transport, production and use, natural hazards, water resources, management and so on.

The Plenary Speech of EED’07 was:

**Natural Rain – Analysis, Modeling, Simulation**

Professor Marius Osteanu
Politehnica University of Timisoara, Romania
Dean of the Faculty of Electronics and Telecommunications

Abstract:

**NATURAL RAIN.** Sprinkle equipment is used to generate water drops for fire protection, for irrigation or for functional and reliability tests of different systems designed for outdoor use. Neither of this known equipment generates patterns of drops according to natural (real) rain. But other applications need detailed tests in atmospheric conditions, with controlled parameters, among which natural rain is one of the most important. For such applications, a rain simulator (generator) with natural parameters, in a controlled environment, has to be developed. To achieve such equipment, next steps must be fulfilled.

**RAIN ANALYSIS.** In order to classify different types of rain, rain parameters have to be understood, defined and measured. Meteorological definition, limited to rain intensity (water quantity / m² / time), is not enough to correctly classify rain types. Technical definition uses a set of measurable parameters (number of drops / m² / time, drops size, drops velocity, etc.), which allows precise classification of rain types. The rain analysis is based on measuring methods and equipment. The paper presents rain classification criteria and, based on large amount of collected data, answers the questions:

* Is rain intensity uniformly distributed in space and time?
* Is the rain drops diameter constant for each type of rain?
* What relationships are between rain intensity, drops diameter and drops velocity?

**RAIN MODELING.** Several sets of parameter recording where used to select appropriate rain models. The model must match the natural rain behavior, so real rain parameters distribution where compared with computed values.
The paper presents additional requirements, imposed to a rain simulator (as desired velocity of the rain drops).

**RAIN SIMULATION.** Different devices (nozzles, sprinklers) where tested and selected, to simulate (generate) each type of natural rain, according to the real set of parameters.

Based on defined parameters for each type of rain and on selected rain generation devices, the design and development of a rain simulator can be started.

**RAIN SIMULATOR.** The paper compares different rain simulators, according to their target application and presents solutions for generating fog, drizzle, light rain, heavy rain, etc.

A complex system, based on mechanical, hydrodynamic and intelligent electronic blocks, controlled by software, is proposed to create a controlled rainy environment, able to simulate natural rain, with all its measurable parameters.

**Brief Biography of the Presenter:**
Prof. Marius Oseteaeu obtained the Diploma of Engineer – with honor, in 1978, and the Ph.D., in 1983, both in electronics, at the Polytechnica University in Timisoara, Romania. From 1978 to 1982 he was with AEM Timisoara company (Electronic Measuring Equipment) as R&D engineer. Starting with 1982 he is with Polytechnica University in Timisoara.


His scientific interest is in real time systems and in image compression. He wrote 12 books, he published 73 articles, he has 9 patents and he was involved in 18 R&D contracts.

He was organizer and chairman of the Special Session Intelligent Systems and Adaptive Control, at the WSEAS International Conference on Dynamical Systems and Control (CONTROL '05), Venice, Italy, 2005. He was chairman of the 7th International Symposium on Electronics and Telecommunications (ETc'06), Timisoara, Romania, 2006, co-chair of the 2nd WSEAS International Conference on Dynamical Systems and Control (CONTROL '06), Bucharest, Romania, 2006, and co-chair of the 8th WSEAS International Conference on Mathematical Methods and Computational Techniques in Electrical Engineering (MMACTEE '06), Bucharest, Romania, 2006. He has co-editor of Proceedings of WSEAS International Conferences CONTROL '05, CONTROL '06, MMACTEE '06.

We would like to thank all members of the organizing laboratories for their contribution to the organization of the conference.

The contents of this Book are also published in the CD-ROM Proceedings of the Conference. Both will be sent to the WSEAS collaborating indices after the conference: www.worldses.org/indexes.
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Economic and environmental advantages of using fly ash as a soil amendment in agronomy

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Abstract: In this paper we highlight the findings of our ongoing studies on the agronomic use of Australian coal fly ashes in the light of pre-existing concerns that the ashes could cause phytotoxicity and, hence, reduced growth and yield of crops. We tested canola on soil treated with an alkaline fly ash added at up to 625 t/ha, and obtained increases in seed yields with fly ash rates of not more than 36 t/ha, beyond which there was no further response in yields. Concentration of B was elevated in the leaves with addition of fly ash to 625 t/ha, while that of Mo elevated in the leaves and grains with addition of fly ash at all rates, but that of Zn was not affected by addition of fly ash. There was a correlation between plant dry weight and tissue concentration of P at flowering, suggesting that addition of fly ash might have enhanced P nutrition. We found in another experiment that both acidic and alkaline fly ashes applied at not more than 12 t/ha significantly increased the pH of acidic soil by up to a unit of 0.4 within 6 months of soil treatment. Much of the benefits of fly ash in terms of amelioration of acidity and other nutritional benefits could be achieved with fly ash applied at not more than 10 t/ha without any detrimental effects on the environment. Salinity (EC < 4.0 dS/m) and B concentration (<60 mg/kg hot water soluble) are the main criteria for selecting Australian fly ashes for soil amelioration. Developing a sustainable application for fly ash in agriculture should reduce the need for its disposal in landfill, while saving farmers at least 30% of the cost associated with treating the soil using lime.

Key-words: agronomy, soil acidity, plant nutrients, phytotoxicity, plant growth

1. Introduction

Soil health as determined by its structural and nutritional characteristics, is a key to viability of agricultural enterprises. Soils in Australia are very old, highly weathered and poor in essential plant nutrients. They have topsoils that are generally low in nutrients while the bottom soils are often dense and poorly permeable to water and plant root. These soils therefore need significant input of nutrients through fertilisation, correction of pH with lime, and structural amelioration through application of gypsum. Furthermore, almost half of the 100 million ha of the agricultural land has pH levels of less than 5.5, with 11 million ha considered extremely acidic (pH < 4.5) [1]. Soil acidification is continuing due to excessive use of fertilizers, increasing inclusion of legumes in farming systems and product removal from the farms. Acidity adversely affects availability of some of the major plant nutrients and structural properties of soil. Fertilisers, agricultural lime and gypsum are therefore common inputs in Australian farming systems.

Coal fly-ash may have significant benefits in the management of these agricultural soils by ameliorating structural and/or chemical constraints to attaining high productivity of horticultural and field crop and of pastures. This is because the fly ash has unique properties that can ameliorate many of the chemical and structural deficiencies, which cause poor soil health and constraint crop productivity. Results from previous studies were inconsistent on the plant responses to treatment of growth media with coal fly ash [2, 3, 4, 5]. These inconsistent results could be mostly associated with different experimental setup and comparison (e.g. greenhouse versus field), and differences amongst the ashes, soils and crops used. Developing modalities for sustainable use of fly ash in soil management will benefit the environment by reducing the substantial amounts of the ash that is disposed in landfill, while providing a significant input for the agricultural sector. For instance, more than half of the 13 million tonnes of fly ash produced annually in Australia is disposed in landfill [6]. Meanwhile, production cost for amendments commonly suit to treat soil could be prohibitive. This cost for lime production, for instance, accounts for between 20 and 50% the total cost of using this material to treating soil acidity [1].

Earlier studies in Western Australia have shown that ash application increased productivity of clovers (Trifolium subterraneum) [7] and turf (Cynodon dactylon) [8, 9] on coastal sands. These studies showed that fly-ash could double the productivity of turf sown on sandy soils, primarily by increasing the water holding capacity and phosphorus availability in the soil.

There is however, a greater potential for fly-ash in the mainstream horticultural and agricultural sector, where high amounts of plant nutrients, including Ca, K, Mg, P and Mo, are removed from the soil and ash application will be of great benefit to supplement these elements. We have been engaged in a series of glasshouse and field studies testing a range of fly ashes on selected crop species in the past few years in Australia. Our ultimate objective is to develop protocols for routine use of fly-ash in soil management. In this paper we briefly highlight progress of this project and the significance of our findings in the light of information available in literature.

2. Potential for coal fly ash in Australian Agriculture

Although fly-ash has many of the beneficial characteristics of agricultural lime and gypsum, to-date there has been no studies that systematically examine all the facets of how fly-ash can be employed in soil amendment for field and horticultural crops in Australia. Our overall objective was to explore the potential for a sustainable use of fly ash in managing agricultural soils in terms of:

1. Identifying desirable characteristics of fly-ashes for agronomic applications
2. Potential benefits of fly ash for ameliorate soil acidity
3. Crop yield benefits due to fly-ash
4. Uptake and phytotoxicity of key elements by plants grown with fly ash

In this paper we briefly highlight progress of this project and the significance of our findings in the light of information available in literature.
for the selection of fly ash in crop and pasture production is rare in literature. Concentrations of trace metals, dioxins, salinity and pH are key properties that would determine suitability of fly ash for agronomic use. Fly ashes from Australian coals, however, have generally low concentration of trace elements (Table 1) compared with coals from other parts of the world [10]. Hence, concentration of these elements in Australian fly ashes are low and well below the threshold limits set by the US-EPA according to Pathan et al. [9].

Table 1. Concentrations of selected total elements (mg/kg) for Australian and international coal fly ashes

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<th>International ashes²</th>
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<td>Acidic ash</td>
<td>Alkaline ash</td>
</tr>
<tr>
<td>Al (x10⁶)</td>
<td>106-134</td>
<td>21.1-60.4</td>
</tr>
<tr>
<td>As</td>
<td>7.4-25</td>
<td>0.36-9.8</td>
</tr>
<tr>
<td>B</td>
<td>7.4-25</td>
<td>11-123</td>
</tr>
<tr>
<td>B (hot water extractable)</td>
<td>2.5-9.1</td>
<td>5.4-13.7</td>
</tr>
<tr>
<td>Ba</td>
<td>13-4310</td>
<td>61-605</td>
</tr>
<tr>
<td>Be</td>
<td>12.0-24.0</td>
<td>5.4-8.6</td>
</tr>
<tr>
<td>Cd</td>
<td>0.38-1.34</td>
<td>0.01-0.19</td>
</tr>
<tr>
<td>Co</td>
<td>11.0-100</td>
<td>6.0-44</td>
</tr>
<tr>
<td>Cr</td>
<td>49.6-130</td>
<td>2.9-34</td>
</tr>
<tr>
<td>Cu</td>
<td>51.6-94</td>
<td>1.8-20</td>
</tr>
<tr>
<td>Fe (x10⁶)</td>
<td>7.1-86</td>
<td>7.62-543</td>
</tr>
<tr>
<td>Pb</td>
<td>59.0-81</td>
<td>1.1-22</td>
</tr>
<tr>
<td>Mn</td>
<td>88-488</td>
<td>5-157</td>
</tr>
<tr>
<td>Mo</td>
<td>8.1-21</td>
<td>0.21-4.2</td>
</tr>
<tr>
<td>Mg</td>
<td>0.1-0.08</td>
<td>0.03-0.19</td>
</tr>
<tr>
<td>Ni</td>
<td>41.2-242</td>
<td>1.5-2.1</td>
</tr>
<tr>
<td>Sr</td>
<td>1.09-3.15</td>
<td>0.15-5.0</td>
</tr>
<tr>
<td>Zn</td>
<td>108-283</td>
<td>5.1-305</td>
</tr>
</tbody>
</table>

Other constituents (mg/kg): ¹from Kellingly et al. [10] and Yumusa et al. [11]; ²from literature [12, 13, 14, 15, 16, 17]; ³from ANZCRI [18] (2004); na, data not available;

Table 2. Responses in the mean pH (± standard errors of means) for soils treated with Australian fly ashes

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Type of fly ash</th>
<th>Rate of ash applied (t/ha)</th>
<th>Resulting pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay loam</td>
<td>Alkaline</td>
<td>0</td>
<td>4.9 ± 0.03</td>
</tr>
<tr>
<td>(pH = 5.41)</td>
<td>(pH = 10.77)</td>
<td>12</td>
<td>5.3 ± 0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>36</td>
<td>5.1 ± 0.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>108</td>
<td>5.1 ± 0.10</td>
</tr>
<tr>
<td>Acidic</td>
<td>(pH = 3.28)</td>
<td>12</td>
<td>4.9 ± 0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>36</td>
<td>5.1 ± 0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>108</td>
<td>5.0 ± 0.13</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>Acidic (pH = 3.28)</td>
<td>4</td>
<td>4.1 ± 0.07</td>
</tr>
<tr>
<td>(pH = 4.45)</td>
<td>Alkaline (pH = 10.78)</td>
<td>4</td>
<td>4.1 ± 0.08</td>
</tr>
</tbody>
</table>

2.2 Potential benefits of fly ash for ameliorate soil acidity
Fly ashes tend to possess high amount of calcium oxides and related basic components, which would nominally be expected to neutralise soil acidity. They therefore have significant agronomic and economic potential in Australia where about 50 million hectares of land are affected by acidity [1] and costing yield losses of more than $1.5 billion dollars annually [19]. This is however often hampered by the poor pH buffering capacity and liming value of the ash [3], and more so for the Class F than for Class C ashes. Class C ashes are derived from low-rank coals, such as lignites, and are high in CaO (> 10%), alkali and crystalline compounds, but low in silica, while Class F are derived from higher-rank coals, e.g. bituminous coals, and contain only modest concentrations of CaO (< 10%) [20]. We have found, however, that Class F fly ashes, such as those produced in Australia, can provide some neutralisation of soil acidity in some soils. Both fine textured clay loam soil and the coarse textured sandy loam showed increases in pH eight months following treatment with variable amounts of either acidic or alkaline fly ash (Table 2). These increases in pH were achieved at much lower rate (12 t/ha) of ash application than would be expected from short-term titration assessment of limiting value of fly ash in the laboratory, which predicted that up to 60 – 80 t/ha of ash would need to obtain liming value equivalent of 1 t/ha of pure lime [21]. Treatment with fly ash also produced increases in the pH of leachate collected during the 5-month growth of canola (Brassica napus) in large intact cores of acidic soil [22].
Table 3. Yield characteristics for canola grown on ash-amended soil in the greenhouse.

<table>
<thead>
<tr>
<th>Ash rate (Mg/ha)</th>
<th>Number of pods/plant</th>
<th>Seed yield (g/plant)</th>
<th>Mean seed weight (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>59c</td>
<td>2.17b</td>
<td>3.95a</td>
</tr>
<tr>
<td>5</td>
<td>75a</td>
<td>2.64a</td>
<td>3.97a</td>
</tr>
<tr>
<td>25</td>
<td>65b</td>
<td>2.65a</td>
<td>4.02a</td>
</tr>
<tr>
<td>125</td>
<td>60c</td>
<td>2.42ab</td>
<td>3.53b</td>
</tr>
<tr>
<td>625</td>
<td>54c</td>
<td>1.96b</td>
<td>3.49b</td>
</tr>
<tr>
<td><strong>SED</strong></td>
<td>5.39</td>
<td>0.364</td>
<td>0.215</td>
</tr>
</tbody>
</table>

Flower numbers were determined from flower stalks soon after flowering. Means within each variable followed by the same letter(s) are similar at p ≤ 0.05.

2.3 Crop yield benefits due to land application of fly-ash

Growth and yield responses by plant to media treated with fly ash have been highly variable. Where positive responses were reported they were often associated with amendment of either physical [5], chemical [23] and/or nutritional [8, 7]. Adverse yield outcomes are generally ascribed to phytotoxicity caused by excessive uptake and accumulation of trace elements by the plant [3]. From these previous studies it can be deduced that the crop response depends on the types of soil, fly ash and crop type, but perhaps more significantly the type and rate of fly ash used. When we tested an alkaline fly ash at rates equivalent to 0, 5, 25, 125 and 650 t/ha on canola in a laboratory study, we found a 23% increase in yield with 5 or 25 t/ha of fly ash (Table 3). Other yield attributes were either increased by, or remained benign to, ash applied at up to 125 t/ha, and any reductions in the magnitudes of any of the response variables occurred only when ash rate was raised to 625 t/ha. It is noteworthy that seed yield was not reduced even with ash rate of 625 t/ha. It seemed in this case that fly ash enhanced P nutrition for canola given that we found a significant correlation between plant weights with tissue P at flowering:

\[ \text{Shoot weight (g) = 0.022x - 7.32, } r^2 = 0.41, n = 48 \]  

where x is P concentration in plant tissue (mg/kg). It had been reported earlier that fly ash enhanced availability and uptake of this P and growth by turf [8].

A later field study in which we applied either an acidic or alkaline fly ash to wheat also showed either benign or increased yield. Taken overall, we observed decreases in plants growth that were supplied with fly ash at rates greater than36 t/ha most probably due to high salinity rather than any particular trace element. This is considered further in the next section below.

2.4 Uptake and phytotoxicity from elemental content of fly ash

One of the major impediments to routine of fly ash in agricultural soil management is the concern over risk posed by the high levels of trace elements in the fly ash, which have been classified as being of either major (As, B, Cd, Hg, Mo, Pb and Se) or moderate (Cr, Cu, Ni, V, Zn and F) concern in terms of environmental considerations [24], which is highly relevant to agricultural applications of fly ash. Fly ashes derived from Australian coals generally have low concentrations of these and other trace elements falling well below the threshold limits set by the US-EPA [9]. While dioxins and furans, along with other organic toxins, in these ashes are usually found to be so low as to be reported as “not detected” with most measuring less than the regulatory limit of 100 ng/kg [18]. Earlier studies with Australia fly ashes identified B as the major cause of phytotoxicity in plants [3], and it was the main reason that had precluded utilisation of fly ash as a soil amendment, particularly in New South Wales, which is the largest state and producer of fly ash in Australia. Dermal effect of excessive B on plants is well established [25, 36], but majority of these earlier studies applied excessively large amounts of ash (equivalent to 180 – 1200 t/ha) and also often to limited volume of soil in containers without leaching. In laboratory studies where fly ash was mixed with substrate even at seemingly low rate of just 10% by weight could translate to 180 t/ha in the field. In our study, introduced above, in which canola was grown in six litres of soil, we found no significant elevation in the uptake of B by canola grown with fly ash applied at up to 125 t/ha (Fig. 1). Amongst the other trace elements only Mo showed elevated concentration in the leaves and in the seeds (data not presented), but the latter was below regulatory limit. A follow-up study using large one meter long cores later also showed that B uptake was significantly elevated only when canola was supplied with 108 t/ha of a particular alkaline fly ash, which was noted for having high amounts of hot water extractable B [22]. Similarly field studies where the roots are not confined, plants grown on fly ash treated soil did not suffer B toxicity [4].

Given the generally low contents of trace elements in Australian fly ashes, individual trace elements may pose minimal risk of phytotoxicity if fly ash is applied at
argonomically realistic rates. It is most
likely that the rather than phytotoxicity
caused by a single element, the salinity of
ash, which sums the magnitude of total
soluble will be of greater concern. Salinity

3.0 Basic protocols in using fly-ash for soil management

Protocols for routine use of fly ash for soil
treatment involve several steps, principally:

a. selection of fly ash
b. rate of ash to apply
c. mode of, and precaution in, application

Each of these is discussed briefly
further.

a. Selection of ash: The first step in
developing protocols for use of fly ash in
land management, especially in an
agricultural context, is the choice of ash.
It is imperative that application does not
exacerbate any pre-existing physical and/or
chemical conditions of the soil.

The aim in agricultural use of fly ash is
then to maintain the soil as near to
optimum conditions for plant growth as
possible. It is impossible to prescribe
detailed guidelines for use of fly ash
tailored for the myriad of individual
ashes, soils, crops and pastures, and their
various combinations. A productive
topsoil should have low salinity with its
electrical conductivity (EC) of < 1.5.0
dS/m, sodicity measured as sodium
absorption ratio (SAR) of < 4.0 and a pH
range 6.5–7.5
(http://www.ruralinstitute.com/courses/ren4904/c-
course_materials.php). On this basis, a vast
majority of Australian fly ashes would
be suitable for soil treatment, because
they have low salinity and sodicity,
along with low concentrations of trace
elements as presented in Table 1. The

pH of ash is of minor consideration
because of the poor buffering capacity
of the ash, and selection of the ash for
agricultural use can be based on the
following criteria:

i. Salinity – this gives a measure of the
amounts of soluble salts in the ash,

which, if high, may cause soil
salinity with prolonged
application of ash. Ashes should
have electrical conductivity (EC)
below 4.0 dS/m, but preferably
below 2.0 dS/m.

ii. Boron content – boron is possibly
the only element found in
considerable amounts in many fly
ashes that could be injurious to
plants on certain soils. An upper
limit of hot water extractable B of
60 mg/kg ash has been set in
New South Wales.

iii. Nutrient content – high
concentrations of cations
(especially calcium, magnesium
and potassium) and phosphorus
are essential for plant growth.

iv. pH – this may be important in
determining the leaching
potential of the constituent
elements within the ash

which, if high, may cause soil
salinity with prolonged
application of ash. Ashes should
have electrical conductivity (EC)
below 4.0 dS/m, but preferably
below 2.0 dS/m.

4. Conclusion

Our studies have shown that the uncertainty
over the agronomic potential of Australian
fly ashes is largely unfounded and need
to be reconsidered. Being mainly Class F and
containing low soluble calcium ions, these
ashes can still be effective smotherants of
soil acidity. These ashes could also be a
significant source of P amongst others for
plants. Development and implementation of
uniform protocols applicable across all
states will establish fly ash to complement,
and in some cases substitute, the
non-renewable amendments commonly used,
such as gypsum and lime. Although our
studies showed potential benefits of fly ash
in agricultural applications, there are several
questions to be addressed. These include
uncertainties over the longevity of the
benefits of fly ash, loading of trace elements
in the soil, bioaccumulation, and efficacy
effects, under sustained use of fly ash for
soil amelioration.

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Abstract: A study on the distribution pattern of rare tree species was carried out in Bukit Bauk Virgin Jungle Reserve (VJR), Terengganu and Gunung Pulai VJR, Johor. A single plot of 2 ha (100 m x 200 m) was established in each VJR by using purposive sampling design. The plot was further divided into contiguous 50 subplots of 20 x 20 m². Based on the IUCN categories, six species are critically endangered and two species vulnerable in Bukit Bauk VJR. In Gunung Pulai, five species each are critically endangered and vulnerable. Both VJRs registered tree species distribution that is random and clumped in different proportions.

Key-words: Spatial distribution, Rare tree species, Virgin Jungle Reserves, Conservation, IUCN

1 Introduction

The establishment of Virgin Jungle Reserves (VJRs) within the timber production areas in Peninsular Malaysia was initiated in 1950's to serve as permanent nature reserves and natural arboretum; control for exploited and silviculturally treated forest; and undisturbed natural areas for general ecological and botanical studies of fundamental importance [1].

Malaysian rain forests are being managed by establishing an extensive network of protected areas since 1930's. For this purpose, a total of 1.39 million hectares of protected areas have been set aside for the conservation of biological diversity in the form of national parks, wildlife sanctuaries and nature reserves [2].

Although these protected areas and VJRs constitute insignificant proportion as compared to the permanent forest estates, many of the VJRs are now seriously depleted with little conservation value [3]. About 30% of the VJRs established have been lost due mainly to