three are Cistus communities, four are Genista hispanica or G. hystrix communities and two are Thymus communities. The other eight communities cannot be clearly included in the previous types because they have intermediate characteristics.

In each one of these areas, cover and height of ligneous species were determined in ten sampling units of 1 m², located at random, and aboveground biomass was cut in three similar sampling units, ligneous species were separated and their dry weight was measured, afterwards they were kept for 12 hours at 100°C. Final results are the mean values of the ten samplings, for cover and height, or the three samplings, for biomass.

Six areas were selected for the evaluation of regeneration of ligneous species. In each one, four sampling plots of 100 m² were established, which were cut, burnt and ploughed, and the fourth was left as a control plot. Before this, ligneous species were sampled and their importance values in terms of cover percentage were stated. Moist weight of aboveground shrub species from the plot cut was measured. Later, dry weight was valued from representative fractions of each species.

These experimental disturbances were carried out in 1985 or 1986 in four of the areas. One of these is a shrubland dominated by Genista scorpius; it is in Monte San Isidro, near León City, at an altitude of 900 m. Another two areas are neighbouring, located 1000-1200 m high, in Cota Isestil and Majada Setiabar, respectively; in both of them, Erica australis subsp.

**INTRODUCTION**

Shrub communities occupy vast acreages in Spain, and particularly in León province. However, they are hardly utilized despite the fact that they constitute a large amount of low cost energy (1). A better knowledge would allow for a better exploitation of these ecosystems.

The traditional use of these areas has usually been for grazing or farming and the normal managements are cutting, burning or ploughing of vegetal biomass.

The aim of this work is to give an overall view of the biomass of several types of shrub communities in León province (NW Spain), as well as their regeneration after the most common traditional disturbances. The evaluation of the biomass makes know the stock of available energy. On the other hand, regeneration studies are very interesting both in the long run as well as the short run because they are the basis in establishing the optimum management and use.

Over the last few years, there have been numerous studies on shrublands (2, 3) and specifically on shrub regeneration after disturbances (4, 5, 6, 7, 8, 9, 10).

**MATERIAL AND METHOD**

In order to evaluate the biomass, 39 shrub communities in León province were sampled (figure 1). Seventeen of them are heathlands, the most common shrubland in León province, five are Cytisus or Genista florida communities.

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**Figure 1. Situation of the areas studied.**
aragonensis is the dominant species, but in the first one it is, in practice, the only ligneous species while in the second one there are some other heathland species. The fourth area is a damp heathland, dominated by Calluna vulgaris and located in Puerto San Isidro, at an altitude of 1000 m.

In these areas, regeneration of ligneous species was studied by estimating the volume (11) and evaluating cover over the following years. The study will be continued until the disturbed plots recover a similar structure to the one it previously had.

In the other two areas the experimental disturbances were carried out in the summer of 1959. Therefore, there are no data on their regeneration yet, but there are data on the initial biomass in the plot cut. In one of the areas, called Restriana and located at an altitude of 1000 m, two series of four plots were established, one in a section dominated by Cistus laurifolius and the other in a section dominated by Cistus ladanifer, because of the great interest in finding out the regeneration after the different disturbances in an ecotone area between the both species. In the other area, Loma Picon, at an altitude of 980 m, two series of plots were also established; in one of them, Cistus laurifolius is the dominant species, in the other it is co-dominant with Erica australis subsp. aragonensis and Arctostaphylos uva-ursi. In this case, the aim is to compare the regeneration between species which can resprout vegetatively (Erica) and species which can only reproduce by seeds (Cistus).

RESULTS AND DISCUSSION

Biomass values of ligneous species in the areas studied were included in table 1. The dominant species are, by their bigger biomass, Erica australis subsp. aragonensis in seven areas, Chamaespartium tridentatum in five, Erica umbellata in four, Calluna vulgaris in three, Erica arborea in two, Genista florida subsp. polygalaphylla in four, Cytisus scoparius in four, Cytisus multiflorus in one, Genista hystrix in two, Genista hispanica in two, Cistus ladanifer in two, Cistus laurifolius in one, Lavandula stoechas subsp. pedunculata in one, and Thymus mastichina in one. The species of great above-ground biomass in each area is usually the species of greater cover as well, coinciding in 32 of 39 areas studied.

The mean height of the upper layer exceeds 2 m in two Cytisus communities (areas 15 and 35) and it is lower than 60 cm in sixteen areas, including all of Genista hispanica and G. hystrix communities, Thymus communities and eight heathlands, while all Cistus and Cytisus communities exceed this height.

There is a clear correlation (Pearson correlation coefficient) between cover and biomass values of species in each area (r=0.50), and the correlation is even greater between biomass and height (r=0.80). The correlation between cover and biomass values of each ligneous species was also calculated. Significant values were observed for Erica australis subsp. aragonensis (r=0.59), Calluna vulgaris (r=0.81), Chamaespartium tridentatum (r=0.68) and Halimion alyssoides (r=0.94), as well as for Cytisus scoparius, C. multiflorus, C. cantabricus and Genista florida subsp. polygalaphylla, considered as a whole (r=0.79), and for Thymus mastichina and T. serpyllum (r=0.90). In all cases the degree of security is 99%.

The above-ground ligneous biomass varies between 7533 g/m², in a Genista florida subsp. polygalaphylla dominated community, with a height of 2-3 m, and 382 g/m² in a Thymus mastichina dominated community. The mean
values of biomass in groups of similar areas are:

<table>
<thead>
<tr>
<th>Community</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cistus communities</td>
<td>4021</td>
<td>2771</td>
</tr>
<tr>
<td>Heathlands (height &gt; 60 cm)</td>
<td>1939</td>
<td>964</td>
</tr>
<tr>
<td>G. hispanica and G. hystricis communities</td>
<td>1426</td>
<td>545</td>
</tr>
<tr>
<td>Heathlands (height &lt; 60 cm)</td>
<td>793</td>
<td>295</td>
</tr>
<tr>
<td>Thymus communities</td>
<td>488</td>
<td>149</td>
</tr>
</tbody>
</table>

With regard to the experimentally disturbed areas, the aboveground biomass from the plot cut is included in Table 2, as well as cover and height of the upper layer before cutting, and four years after cutting. The greatest biomass is detected in the area called Loma Picon 1 (440 kg of moist weight in 100 m², which corresponds to 325 g/m² in dry weight); in this area Cistus laurifolius is clearly dominant, with big and old specimens (there are other ligneous species, but their biomass is not important). The other three Cistus communities also have greater biomass than the heathlands, while the least ligneous biomass was observed in Monte San Isidro (35 kg of moist weight in 100 m², which corresponds to 192 g/m² in dry weight); the dominant species is Genista scorpius, although its cover is less than 25%.

The regeneration of ligneous species is very little in Monte San Isidro, in part, due to the effect of grazing by sheep and rabbits. Cota Isentil and Majada Setivar heathlands are the most recuperated, after the fourth year of the disturbances. Erica austrois sp. aragonesensis can resprout after burning or cutting and it can also reproduce by seeds, the latter being the only possibility in the ploughed plot, with slower regeneration. In Puesto San Isidro, Erica tetralix recovers faster than Calluna vulgaris because C. vulgaris does not resprout. However, the regeneration process is not still finished, so it is not possible to assure that this latter species will not recuperate its initial dominance as it tends to increase its cover. There are still no data on regeneration of Cistus communities.

**TABLE 2**

Moist weight and estimated dry weight in the experimental cut plots.

<table>
<thead>
<tr>
<th>BIOMASS</th>
<th>BEFORE CUTTING</th>
<th>AFTER CUTTING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEAN WEIGHT</td>
<td>MEAN WEIGHT</td>
</tr>
<tr>
<td></td>
<td>(kg/100 m²)</td>
<td>(g/m²)</td>
</tr>
<tr>
<td>Genista scorpius</td>
<td>35</td>
<td>50.6</td>
</tr>
<tr>
<td>Rosa sp.</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Erica australis</td>
<td>165</td>
<td>50.4</td>
</tr>
<tr>
<td>Calluna vulgaris</td>
<td>31</td>
<td>32.1</td>
</tr>
<tr>
<td>Erica unbelata</td>
<td>14</td>
<td>24.3</td>
</tr>
<tr>
<td>Arctost. us-ursi</td>
<td>7</td>
<td>24.8</td>
</tr>
<tr>
<td>Vaccinium myrtillus</td>
<td>1</td>
<td>24.9</td>
</tr>
<tr>
<td>C. laurifolius</td>
<td>115</td>
<td>52.0</td>
</tr>
<tr>
<td>Erica tetralix</td>
<td>22</td>
<td>24.0</td>
</tr>
<tr>
<td>Vaccinium myrtillus</td>
<td>11</td>
<td>24.2</td>
</tr>
</tbody>
</table>

**CONCLUSIONS**

The high biomass observed in some of the shrublands studied shows their great stock of available energy, although the election of the best management and use would need ulterior studies in each concrete case. A reasonable use could lead to an improvement of these communities and, simultaneously, to an economic profit. This would allow for a greater appreciation and protection of shrublands, traditionally considered as marginal areas.

**REFERENCES**


Biomass Resources for Energy in Malaysia

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Abstract

This paper describes the range of biomass resources in Malaysia, and the current uses and extent of utilisation. Most of the resources are wastes of which only a small fraction is employed for combustion in the traditional industries of Malaysia. The types of biomass and wastes are described with the current recovery rates and uses. Some trends are identified for changes in arisings and opportunities identified for greater utilisation.

Introduction

In a developing country such as Malaysia, socio-economic advancement depends largely on natural resource exploitation. Malaysians, like their counterparts in the developed countries, have expectations for and the right to a better quality of life. Ever since Independence in 1957, this goal has been pursued by successive Malaysian governments through the implementation of pragmatic socio-economic policies and programmes embodied in the respective development plans called the Malaysian Plans (1-4). As the country is endowed with only limited mineral resources, Malaysia has had to base its socio-economic strategies and programmes in its most abundant natural resources, namely, forest and land. The forest has generated the much needed funds for development while the land has provided employment opportunities for the creation of new wealth. As a consequence, successive development plans have been dominated by large scale land development schemes.

Most of the land developed for crops (such as rubber, oil palm and paddy) were converted from the forest. As a result, large tracks of forest were cleared within a relatively short period. The massive clearance of forest and the rapid development of the agricultural sectors have resulted in the generation of a high amount of biomass wastes. The primary objectives of this paper are:

1. To highlight the quantity and form of forestry, and agricultural wastes
2. To identify the current utilisation of biomass for energy
3. To suggest possible alternative for utilising biomass residues

Forestry Residues

The forest is the source of timber which generates the necessary revenue for development while the land provides opportunities for gainful employment and the creation of wealth. The clearing of forests within a relatively short period has led to the generation of a huge amount of...