

# Maquis for Biomass<sup>1</sup>

N. S. Margaris<sup>2</sup>

In the Mediterranean basin region, about 200,000 hectares are burnt every year. In moderate estimations, the aboveground biomass lost is of the order of magnitude of  $1.2 \times 10^7$  tons, and according to Le Houerou (1973) the direct damage is at least 50 million dollars. From the other side, great amounts of money are spent for fire-fighting. The same situation prevails not only in the regions of the Earth with mediterranean-type climate (California, S. Africa, Chile, Australia) but almost in all ecosystems, except for those in the very cold and/or very humid climates. In Canada, for example, forest fires cause a loss of the order of magnitude of 50 million barrels of oil per year (Bene et al. 1978).

Nowadays, when liquid fuel deficiency distresses extended areas of the Earth, it is time to stop this great loss of energy and organics. Greece will be taken as an example in the discussion because, first, the author has an adequate experience of this region and, second, because this country has to confront many oppressive problems, such as fuel, wood, and paper deficiency and great expenditures on fire-fighting. If these problems are studied all together, it is quite probable that the one will offer the solution to the other.

## CURRENT PROBLEMS RELATED TO THE LACK OF LIQUID FUELS IN GREECE

Greece has to import the whole quantity of liquid fuels needed. The anticipated oil production from 1981 of 25,000 barrels per day will cover only 10 percent of needs. Even before the liquid fuels price raising of June 1979, the Greek Government has been trying to diminish their consumption. Nevertheless, it is still increasing at a rate of 10 percent per year. The need of saving foreign exchange for oil purchase maximizes the problem, especially during the last period, when price raising has been extremely high. Petrol price, for example, came to be 0.85 US \$ per liter (not gallon!) and it is most possible one of the highest in all the world. Beside this increase, the Government proceeded to a whole series of relative ways and means. The

---

<sup>1</sup>Presented at the Symposium on Dynamics and Management of Mediterranean-type Ecosystems, June 22-26, 1981, San Diego, California.

<sup>2</sup>Professor of Ecology, University of Thessaloniki, Thessaloniki, Greece

---

Abstract: Mediterranean regions, like Greece, have to face many problems, such as fuel, wood and paper deficiency. In addition to that, great amounts of money are spent every year for fire fighting. The suggested harvest of mediterranean-type ecosystems every 10 years will contribute to a combined solution of all these problems.

---

most important among them is the prohibition of cars circulation every second weekend from 5 o'clock in the morning of Saturday to 5 o'clock in the morning of Monday. Others were the shortening of oil disposal for heating or cooling purposes, the turning off lights of shop boards and advertisements, in streets and national roads, the application of differential office and shop hours, the closing of every place of amusement at 2 o'clock in the morning, etc.

These means led to a quite significant life disturbance of the Greek population after 1979 summer. At that time there appeared a tendency on behalf of those who could afford it, to purchase a second car - fact not so common in Greece - in order to avoid the problem of family transport during week-ends. However, the Government imposed such a heavy taxation that car purchase became problematic, especially, for those who had none. In this way cars price, in Greece, is almost three times higher than that in the other western countries. In the same time, the Government promised to give more money to the research on other energy sources, something not realized yet. Inflation (25 percent for 1980) and the tremendous increase of payment balance deficit - since imports far exceed exports - which was during 1980 about 2.0 billion dollars, are two major problems in Greek economy. Large amounts of foreign exchange are also expended for the import of wood and paper, since the Greek production covers only 25 percent of the needs for the first and just 10 percent for the second.

## THE NATURAL ENVIRONMENT

The total surface of Greece (9 million people) covers 13 million hectares from which 20 percent are forests, 30 percent cultivated land, 10 percent urban and semi-urban areas, roads, water surfaces, etc., while the rest 40 percent correspond to mediterranean-type ecosystems. Two types of mediterranean climate ecosystems can be discerned; maquis and phrygana. Plants dominating in maquis are adapted to the summer drought by means of evergreen sclerophylly, while those in phrygana (coastal sage) by the mechanism of seasonal dimorphism.

The combination of high temperatures and water deficiency during the summer, leads to a high frequency of recurring fires in them. The relation of this climatic type with fire has been since long noticed (Griesebach 1872). Shantz (1945), in his review for the mediterranean type ecosystems of California, refers to them as "fire-type" and

says further: "... that this type was ever free from fires seems unlikely". According to Mutch (1970), ecosystems subject to frequent fires for thousands of years have developed, in the course of evolution, properties, which make them extremely flammable.

Biswell (1973) says: "Fire in chaparral is both natural and inevitable. It has always occurred and probably always will, because vegetation becomes extremely dry near the end of a long, hot, nearly rainless summer. At that time, also, humidity may be extremely low and winds high".

As we have already mentioned mediterranean type ecosystems are called "fire-induced" or "fire-adapted". Plants dominating in them, have developed such adaptations which not only help them to survive after fire attack but periodic fires every 15-20 years or so appear necessary to maintain their good health.

Plants recovery after a fire, follows, basically, two ways. Perennials, dominating in maquis, usually recover by resprouting. Naveh (1973) refers to them as obligatory resprouters, while to those dominating in phrygana as facultative resprouters, since they recover both by resprouting and through their seeds, the germination of which is activated after a fire. The plant species Pinus, found in maquis, and Cistus, in phrygana, recover only through their seeds.

The growth of the new plants is very quick and after 5-10 years, the burnt area cannot be distinguished from the unburnt. The quick recovery can be attributed to an increased photosynthetic rate of the resproutings, since after fire the new leaves are larger and have a greater chlorophyll content per unit of weight (table 1).

## THE SOCIAL ENVIRONMENT

For reasons which are beyond the scope of this article, the Greek society considers fire as a terrible and unnatural event, which did not happen in earlier times. From that derives the governmental policy, based on fire exclusion. We must mention, however, that both in earlier times and today fire burned every year the same percentage of land (figure 1).

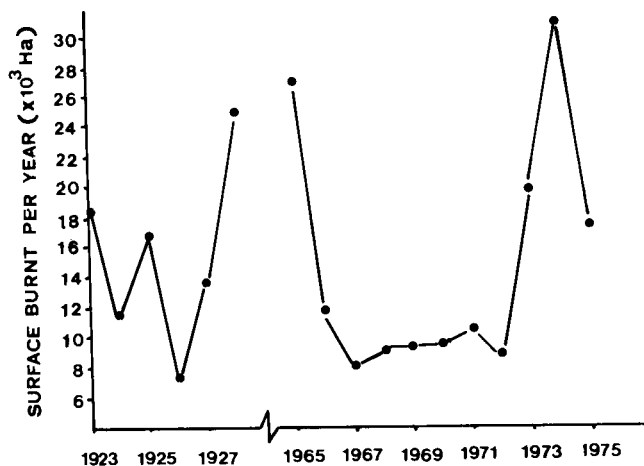


Figure 1--Area burnt per year in Greece.

The exact effect of fire is essentially confused with overgrazing. But the fact is, that the after fire resproutings are either eaten or trampled by the passing animals and only the combination of fire and overgrazing leads to the degradation of

Table 1--Chlorophyll content (mg.g<sup>-1</sup> leaf dry weight) in leaves of normal and burnt plants. Fire occurred in July 1976 (Arianoutsou 1979).

	January 1977		April 1977	
	Normal	Burnt	Normal	Burnt
<u>Phlomis fruticosa</u>	2.0	3.5	2.4	4.6
<u>Sarcopoterium spinosum</u>	2.3	5.7	2.2	5.0
<u>Euphorbia acanthothamnus</u>	4.7	5.4	4.9	5.2

ecosystems and to the "Asphodel deserts".

In this way, quite often during the summer months the most important article of the Greek newspapers concerns fires which almost always are attributed to criminal activities. By being opposed to such an oversimplified explanation we do not deny its validity in a few cases, since it is known that shepherds, themselves, in NW Greece (Papanastasis 1977), Crete island and other places, light on fires which, they believe, improve the pasture production, since the first one or two years after the fire an interlude of herbaceous vegetation appears in the burnt area. The way with which the Greek State confronts fires, is excellently described by Biswell (1974) although he is occupied with the situation in California. Of course, the available material and the experience of the Greek firemen are still far back.

"In spite of man's capability to fight wildfires with the most modern aerial and ground equipment and the best trained firemen in the world, it seems certain that wildfires in chaparral cannot be completely prevented. Good intentions and large expensive efforts in fire control do result in fires at less frequent intervals. But with longer time between fires, the fuels continue to build up and become more widespread, and when fires do get out of control, the toll in human life, natural resources, and cost is enormous".

Biswell (1974) proposes prescribed burning every 15-20 years for confronting these problems. In Australia, in areas of relative climate, this has already become a reality with the use of aerial ignition (Vines 1968). Before proceeding further we must mention that the chief objection to burning mediterranean type lands both in California and in the Mediterranean basin is its alleged detrimental effect on soil erosion and stability. Sampson (1946), in California, expressed his opposition to the rash and broad generalization and suggested, in contrary, a fire consideration taking into account the specific ecological conditions. The same suggested later on Naveh (1974) for Israel and Liakos (1973) for Greece.

The official policy of fire exclusion and the confusion of protection of environment with protection of forests as well as convenience in using liquid fuels led Greece in less than 20 years in complete dependence upon oil as a fuel. Therefore, 80 percent of the Greek population uses oil for heating purposes. During only the period 1970-1975 the production of oil stoves was 600,000 items. In the same time the prohibitions of wood cutting result inevitably in fuel accumulation as aboveground biomass, which will cause catastrophes, when fire, early or late outbreaks.

ARE THERE MEANS OF FACING THESE PROBLEMS?

The above mentioned may be summarized in that from the one side there is a social disturbance due to the oil deficiency and the excessive demand of foreign exchange for its purchase as well as for the import of wood, paper, animal food, and from the other side the problem of fires which in the way it is faced will lead to severe damages. What we propose is the utilization of fire-type ecosystems. Rotating harvesting of them will, if not exclude, moderate in a considerable extent all these problems. We believe that our suggestion surpasses that of Biswell (1974) for prescribed burning in that not only the fire problem is faced but also energy and organics which these ecosystems contain are not lost.

In figure 2 our suggestion is presented in a simplified way. According to the present data, concerning the frequency of fires, it seems that an ecosystem, aged 20 or 30 years is mature to be burnt (Trabaud 1973, Biswell 1974). However, the net productivity, especially as the ecosystem approaches the climax is always declining. Therefore, 10 years after fire the aboveground biomass is only slightly increasing. If instead of waiting a fire outbreak, we harvest the ecosystem every 10 years, the possibilities of a catastrophic fire are reduced and in parallel to that the net productivity is maintained at a high level, and consequently, there is a gain in energy and organics.

The next step is to find the appropriate areas where such a harvest can take place. Since, in Greece, mediterranean type ecosystems comprise 40 percent of the total surface, a 4 percent harvesting every year will yield about  $94 \times 10^{12}$  kcal, which is equivalent to over 80 percent of our imports in oil (Margaris 1979). It is certain that the mountainous relief of Greece does not permit for the time this kind of harvesting. However, such a project may be applied in maquis, which consist about half of the surface covered by mediterranean type ecosystems, but contain 80 percent of their total above ground biomass. A ten year rotating harvesting of those maquis located on level ground, which cover about 10 percent of the total Greek surface seems quite feasible. It is estimated that the aboveground biomass contained in them is about  $6 \text{ kg.m}^{-2}$ . Therefore, harvesting 1 percent of the Greek surface (or 10 percent of maquis ecosystems, which may be easily harvested) every year, will yield a biomass of the order of magnitude of  $12 \times 10^6$  tons. This amount is equivalent to over 40 percent of our oil imports. The fuel needed for this harvest will not be too costly, in these level ground areas, if self-propelled harvesting machines are used, like those suggested by Mitre Corporation (1971) for harvesting large-scale energy plantations with harvesting ability of 35 tons per hour.

The estimations of a prefeasibility analysis published in a previous work (Margaris 1981) have shown that the harvesting cost of a 23,000 hectares unit harvested by 1/10 every year will not surpass 3 US \$ per ton dry matter, which seems quite satisfactory.

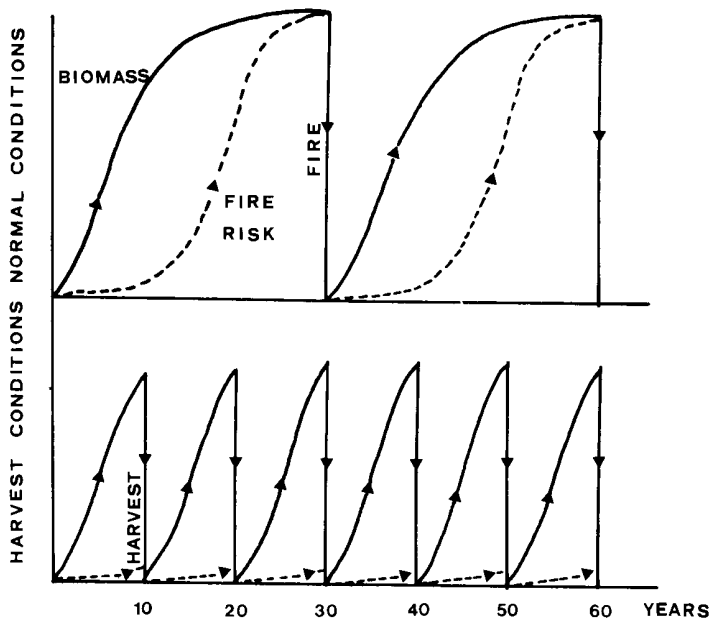


Figure 2--Biomass and fire risk in Mediterranean-type ecosystems under natural and harvest conditions.

#### CAN HARVESTING SUBSTITUTE FIRE?

One of the first remarks when harvesting is suggested is whether the harvested system recovers in the same way as the burned system.

As a first attempt to give an answer to this question we have started observations in regions cleared in the past by the National Electric Corporation in order to install high voltage lines.

In harvested areas it seems at first sight that the system has developed quite normally. Of course it is obvious that there is less biomass in the harvested area, but it must be taken into account that the unharvested area of the picture has reached the climax and has not suffered the fire impacts for the last 40 years.

Another observation is related with erosion which is believed to get intensified after harvesting. However, reality seems to counteract the pessimism of the theory.

In the profile of figure 3 we show schematically the biomass location in the harvested and unharvested areas. It can be seen that biomass is denser over the height of 1 meter in the unharvested whereas below 1 meter in the harvested area. Consequently, in the unharvested area there are but the trunks of the bushes at the height of 0-1 meter, while herbaceous vegetation is totally

absent. As a result the soil is swept away forced by the downwards movement of water. On the contrary, in the harvested area the resproutings are in soil contact thus alleviating the erosion effect.

Of course we must say that with the harvesting we propose a quantity of nutrients will be taken away from the systems. We have shown, however, in a previous work (Nargaris 1979) that they will be very probably replaced by the nutrients, coming with the rain. Also, our first observations in the areas already harvested by the Electric Corporation show that Papilionaceae species increase their contribution to the biomass, something very interesting.

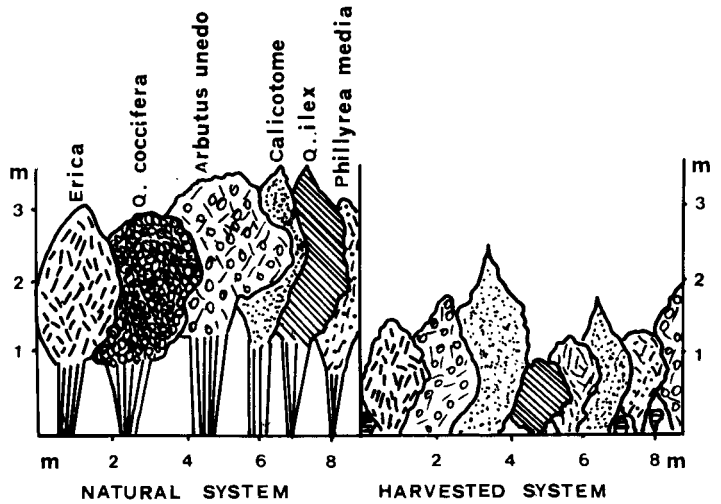


Figure 3--A schematic biomass profile under natural and harvested conditions in an area in North Greece harvested before 7 and 17 years.

#### ECOLOGICAL ADVANTAGE

It is mentioned above that the technique of prescribed burning is used both in Australia and in California in the management of mediterranean-type ecosystems. However, it must be taken into account that with this technique the natural ecosystems are successfully preserved but on the other hand immense quantities of energy and organics are lost; moreover, there is always the danger the fire become uncontrolled.

In comparison with energy plantations the advantages are much more. There are no problems such as sensitivity, diseases, inputs of energy and fertilizers, common to all monocultures.

However, what is more important in our opinion, is the possible increase of the system diversity.

Ten years after the initial harvesting there will coexist areas harvested before 1-10 years, so that different stages of the post-harvest succession will be present in the same ecosystem. Furthermore, there is a possibility of 1X2X3X...X10 combinations between different post-harvest stages which can be brought into contact. In this way, the roles, the organisms can play in the system, are multiplied with a subsequent possible increase of the total number of both plant and animal species in the post-harvest period.

#### LITERATURE CITED

- Arianoutsou, M. Effect of fire in a phrygianic ecosystem. Ph. d. Thesis. University of Thessaloniki, Greece; 1979.
- Bene, J.G., Beall, H.W. and Marshall, H.B. Energy from biomass for developing countries. International Development Research Centre-MR3 Ottawa, Canada; 1978.
- Biswell, H.H. Effect of fire on chaparral. In: Fire and Ecosystems. T.T. Kozlowski and C.E. Ahlgren (Eds) Academic Press, New York; 1974; pp. 321-364.
- Griesebach, A. Die Vegetation der Erde nach ihrer klimatischen Anordnung. Engelmann, Leipzig; 1872.
- Liakos, L.G. Present studies and history of fire in Greece. Proc. 13th Annual Tall Timbers Fire Ecology Conference; 1973; pp. 65-96.
- Le Houerou, H.N. Fire and vegetation in the Mediterranean basin. Proc. 13th Annual Tall Timbers Fire Ecology Conference; 1973; pp. 237-277.
- Margaris, N.S. Can we harvest mediterranean type ecosystems to obtain energy and organics? In: Biological and Sociological Basis for a Rational Use of Forest Resources for Energy and Organics. S. Boyce (Ed). Asheville, North Carolina: USDA/Forest Service Southeastern Forest Experimental Station; 1979; pp. 121-128.
- Margaris, N.S. Maquis for biomass: Costs and benefits. In: Components of Productivity in Mediterranean Regions (N.S. Margaris and H.A. Mooney, Eds), Junk, The Netherlands; 1981; (in press).
- Naveh, Z. Effect of fire in Mediterranean region. In: Fire and Ecosystems. T.T. Kozlowski and C.E. Ahlgren (Eds), Academic Press, New York; 1974; pp. 401-434.
- Papanastasis, U.P. Fire ecology and management of phrygiana communities in Greece. Proc. Symp. on the Environmental Consequences of Fire and Fuel Management in Mediterranean Ecosystems. Palo Alto; 1977; pp. 476-482.
- Sampson, A.W. Plant succession on burned chaparral lands in North California. California Agricultural Experimental Station Bull., 685; 1944; 1-144.
- Shantz, H.L. The use of fire as a tool in the management of the brush ranges of California. Sacramento, California; California State Board of Forestry; 1947.
- Trabaud, L. Experimental study on the effects of prescribed burning on *Quercus cocciifera* garrique: Early results. Proc. 13th Annual Tall Timbers Fire Ecology Conference; 1973; pp. 97-129.
- Vines, R.G. The forest fire problem in Australia a survey of past attitudes and modern practice. CSIRO, Aust. Sci. Teacher's J.; 1968; pp. 1-11.