Factors affecting fuelwood production and consumption in Greece

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Abstract. Wood, one of the most important renewable energy sources (RES), has been used as a fuel since ancient times. Wood was the first material to be used for energy production. Gradually its use as a fuel dwindled as other sources gained popularity. However, following the oil crises of the 1970s, various countries switched to RES and in particular to wood as a primary heat source. The current paper attempts to highlight the factors that affect fuelwood production and consumption in Greece in recent decades and to propose a number of policy measures. More specifically, fuelwood production in Greece over the last decades is constantly declining mainly due to overgrazing, forest fires, urban sprawl, poor management and inadequate transport infrastructures; all these factors considerably impact the country’s forest productive capacity. Several decades ago, fuelwood was in great demand in Greece. Gradually, however, it lost its popularity to other heating fuels and was only used in rural residences or in a small number of urban homes. The last decade, however, owing to the deep economic crisis afflicting the country, there has been a marked increase in the demand for fuelwood mainly by low-income households.

1. Introduction

Global demand for energy is bound to remain strong in the coming decades owing to an expected increase in the human population coupled with positive rates of economic growth [1].

The emergence and evolution of our civilization is directly linked with per capita energy consumption. Energy is a significant capital resource for the economic growth of countries. Developing countries in particular rely heavily for their economic well-being on the increasing consumption of specific energy sources, a fact that necessitates the implementation in these countries, to a greater extent than in their developed counterparts, of special energy programs aiming at optimizing their control of fuel and energy sources. Insufficient supply of energy is a grave restrictive factor for the economic development of these countries. In general, energy must be supplied abundantly to serve the basic social and economic needs, to the extent possible, of most groups of local populations [2].

The oil crises of the 1970s resulted in countries switching to renewable energy sources (RES), one of which is wood [3]. Renewable energies are already playing a role both at national and international
level as a result of the need to replace traditional energy sources such as fossil fuels and to fulfill the commitments resulting from the Kyoto Protocol [4].

More specifically, the need to protect the environment and ensure energy sufficiency and the smooth supply of fuels has urged countries, mainly the developed ones, to search for, and harness, according to the principles of sustainable exploitation and rational management, renewable energy types, including biomass coming from forests in various forms such as fuelwood, charcoal, logging residues, and residues wood from industrial processing [3].

Woodfuel is the oldest energy source. Over two billion people in developing countries are still dependent mainly on woodfuel (fuelwood and charcoal) for cooking and heating purposes. Fuelwood and charcoal are the main forms of woodfuel [5].

In Greece, in the first decades following the early 1950s, the use of fuelwood was particularly prevalent especially in rural areas. Gradually, its popularity declined, but the oil crises of the 1970s, and the switch to fireplaces both in urban residences and in country houses led, to a certain extent, to higher demands for fuelwood [6,7]. However, over the last decade, the economic crisis that has been plaguing the country has brought about a marked increase in the demand for fuelwood.

2. Fuelwood production in Greece

According to the first forest inventory conducted by the Ministry of Agriculture, industrial and non-industrial forests cover 6,513,068 hectares, which corresponds to 49.3% of the total area of Greece. More specifically, industrial forests account for 25.4% and non-industrial for 23.9% of the land. The merchantable volume in industrial forests amounts to 138,107,132 m$^3$ [8]. The natural forests of the country, albeit growing satisfactorily in mountainous and semi-mountainous regions, remain in poor condition, as far as the quality of the stock is concerned and the potential to produce construction timber of high-quality standards. On the other hand, in coastal and low altitude areas, natural forests seem to be showing decreasing trends and definite signs of degradation due to extensive disasters from fires and changes of use.

The largest producer of forest products, fuelwood included, in our country is the State (Forest Service), an expected fact given that approximately 64% of forests belong to the Greek State and 36% to private individuals.

Fuelwood constitutes a basic commodity especially for Greece's mountainous populations and for this reason local inhabitants react to any fuelwood regulatory plan or framework for economic reasons, habit and, to a certain extent, tradition. However, the extraction and removal of large quantities of fuelwood from Greek forests has been performed many a time in the past in irrational manners and according to the desires of the mountainous homeowners, resulting in the degradation of forests, thus generating all sorts of adverse environmental, economic, and social impacts [9].

Fuelwood and charcoal can contribute both financially and socially to the development of areas that have fully exploited forests, whose principal management objectives include their energy utilization [2].

From an investigation of the Activities Reports issued by Forest Services over the last decades it is revealed that timber production in Greek forests is constantly decreasing both in terms of technical and industrial wood and fuelwood [10]. Fuelwood production in Greece, which in the 1960s amounted to approximately 2,000,000 m$^3$/year, has been witnessing a declining trend in more recent years, falling to nearly 50% in 2019 (950,000 m$^3$/year).

Factors causing reduced forest productive capacity and, consequently, affecting fuelwood production include:

1. The compilation of management plans is based on instructions and specifications dating back to the 1950s and 1960s, which are long outdated, obsolete and in urgent need of reform. The re-compilation of management plans every decade as imposed by legislation has been abandoned to a great extent or, if it does take place, this occurs only after serious and persistent efforts of the personnel employed in admittedly understaffed Forest Services. The shortage of staff in conjunction with long-lasting under-funding of the above services invariably leads to non-existent or inadequate
cultivation and care of forest stands, a situation that entails unpredictable consequences on their future development [11].

2. The administrative isolation of regional Forest Services from the central service makes it exceptionally difficult to disseminate forest policy, which is currently agreed upon at a European level, increases bureaucratic burdens and generates administrative confusion over roles and responsibilities among regional staff, who are in essence the driving force in matters of forest policy implementation [11].

3. The rapid urbanization of the population after the early 1950s, the dramatic effects of which are closely associated with the economic withdrawal of the population from the primary sector, the sharp reduction in the size of populations living in woodland areas, the decline in public and, consequently, political interest in the countryside and the incomplete management of forest ecosystems [11].

4. Forest maps and the national cadastre have not yet been completed, whereas the creation of “dasologio” has not even been initiated yet. Both these records constitute the cornerstone of forest management contributing to the protection of forest lands and, therefore, their productive reconstruction and restoration; they are also valuable tools in curbing the issue of illegal changes in land cover.

5. The pressures exerted by livestock farming and especially by uncontrolled goat grazing is an important factor that has led several Greek forests to degradation. Mountainous livestock farming is currently practiced in a traditional way, resulting in high pressures on our country's productive forests.

6. The spread of urban uses to countryside has adversely affected forests either directly or indirectly. Improvements in transport infrastructures, the expansion of urban plans, urban sprawl, unauthorized building works and illegal housing, and increased legal building activity, too, create a complex negative background for forest land uses, consistently reducing its size [12].

7. Lack of spatial planning and the absence of an effective system of organizing and managing natural areas and the countryside.

8. Forest fires that have been following a rather upward trend over the last decades are a persistent problem in the country. Fires in Greece are the most common means of changing land uses. Through fire clearing, dense forest areas that were once used for livestock farming and logging are converted into degraded, fragmented and fire-prone landscapes. The ever-growing value of land in the vicinity of major cities, seaside resorts, and tourism development centers is a cause of arson. To make matters worse, the state's inability to regulate the tenure rights of lands that are in such demand and of such high value, creates further frictions between the state and citizens. This complicated background has been taken advantage of by profiteers, speculators, trespassers, and pseudo-owners that, with the use of fire as a pretext, have long been usurping public lands [13].

3. Fuelwood consumption
Over the last decade, sharp increases in energy prices, coupled with severe income cutbacks as a result of the economic crisis affecting Greece, have multiplied the number of vulnerable households, forcing them to opt for energy solutions other than fossil fuels especially for their heating needs. More specifically, due to income reductions, a large number of citizens can no longer afford the heavily taxed energy prices. Electricity prices have risen in Greece considerably more than in other European regions due to regulatory measures (taxes, greenhouse gas emissions trading etc. – time periods 2009-2012) or due to fluctuations in oil prices or imported energy prices. This has been a decisive factor significantly impacting energy poverty in the country, as the spiky increases in domestic heating costs have led to a reduction in oil use from 65.9% to 38.1%, a development that took place without a simultaneous implementation of energy efficiency measures or initiatives in most residences [14].

In Greece, approximately 60% of homes were built before 1980, with the highest percentage (22.6%) being completed between 1971 and 1980. Therefore, the greatest part of this building stock does not have sufficient thermal insulation in the building envelope, while heating units are energy-intensive owing to age and poor maintenance. In addition, due to age, most single-family houses are less insulated than apartment buildings. The existence of a roof thermal insulation is more common in
apartment buildings, but, although it considerably improves the rooftop energy behavior, it does not significantly contribute to the reduction of energy needs in the entire building. Finally, a high percentage of buildings have single-glazing windows. Residential heating systems are dominated by central oil-fired boilers and electrical systems while a significant percentage of single-family homes use biomass fuel (fuelwood, pellets) as a primary source of heat [15].

The economic recession impacting Greece has resulted in an excessive increase in the demand for fuelwood from broadleaved species, mainly oak and beech. At the same time, it aggravated pressures from mountain populations demanding to satisfy the largest part of their heating needs from forest products, a trend that was manifested by their returning to woodstoves, fireplaces, and wood-fired boilers [16].

A survey conducted with a sample of approximately 200 households investigating user habits in relation to energy consumption for heating in recent years shed light on the serious difficulties faced by Greek households in covering their heating needs because of the economic crisis and high taxation on heating oil [17].

Generally speaking, energy consumption is determined by a plethora of demographic and economic variables such as consumer age, family size and annual household income; an equally important variable is residence size [18]. A recent research revealed that energy consumption is positively correlated with available income, educational level, age, and number of household members that are employed [19].

According to Blioumis and Christodoulou [6], factors affecting fuelwood consumption include: (a) population size; (b) the percentage of a country’s rural population; by and large, rural populations tend to cover their needs by resorting to natural resources; (c) the type of rural residence, its size and the technological specifics of its thermal insulation; (d) the changes in living standards; (e) the prevailing climatic conditions; (f) wood burning technology for the production of thermal energy; (g) state intervention policies in the fuelwood market; (h) wood calorific content in comparison to the corresponding content of other fuels; (i) fuelwood’s relative price compared to the price of other fuels and the relative cost of converting them into thermal energy.

The fuelwood market in Greece is characterized by the participation-intervention of the Forest Service in price-fixing processes and the distribution of the products, as the Forest Service is the largest producer of forest products. Fuelwood sales are usually at satisfactory prices, while part of the demand is also covered by technical wood made available as fuelwood by members of forest cooperatives.

Damalas (1976) [20] investigated the factors that affected the consumption of forest products during the period 1950-1972 as well as the predicted consumption of various categories of forest products for several years. He found out that the per capita income index negatively affects fuelwood consumption.

Albanis et al. (1982) [21] in their research on forest products in the Greek market and their future trends predicted that the future fuelwood needs of the country would be reduced by 2010.

Individual income appears to negatively affect fuelwood consumption, while the population size affects it positively [22].

In another research paper, it was found that woodfuel consumption is negatively affected by the per capita income. As the average annual family income increases, the average annual woodfuel consumption per household decreases and this correlation is very strong [23].

Papastavrou (2008) [9] argues that, in general, the factors that affect production, consumption and imports-exports of wood are as follows: (a) socio-economic conditions and demographic changes; (b) technological developments; (c) living standards; (d) environmental constraints; e) economic recession and inflation, and (f) international economic relations.

In a survey with questionnaires in the Kozani Prefecture (Northern Greece) it was found that most of the consumers of fuelwood reported that a significant problem they were faced with was its storage in their residence and its transportation from the storage area to the heater. In other words, consumers are concerned about the extra work required for fuelwood in relation to other sources of heat. In the
same survey consumers also reported that they can easily find available on the market the quantities of fuelwood they need [24].

Moreover, in another survey with questionnaires conducted in a Northern Greece region (Grevena) it was found that households with a larger number of members consume more fuelwood. Single-family homes seem to consume more fuel than apartments, probably because there is plenty of storage space available, and also because they are more exposed to cold weather and consequently have greater heating needs. The consumption of fuelwood for those who use it for both heating and cooking was on average 8.64 tons / year [25].

Chalikias et al. (2012) [26], through a questionnaire survey carried out in a southern Greece area, found that consumer age is positively associated with fuelwood consumption. Also, medium income families depend less on fuelwood, compared to the richer or poorer households, while the retail price of fuelwood substantially affects its consumption. In addition, in the same research it has been found that general environmental and ecological concerns of consumers could affect their attitude towards fuelwood consumption.

In a questionnaire survey in the Larissa Prefecture (Central Greece), it was revealed that lower income families consume more fuelwood in comparison to medium income families, the latter depending less on fuelwood as compared to richer or poorer households. In addition, the survey showed that fuelwood consumption is positively correlated with the age of the homes. Residential fuelwood consumers are willing to reduce their consumption in case of price increases. Finally, fuelwood consumers who can easily purchase fuelwood from the market consume the largest amounts of fuelwood compared to those who report that they have difficulties in stocking up. The estimated average annual fuelwood consumption per household is 6.82 tons [27].

4. Conclusions and Recommendations
The current paper aims to contribute to the investigation of factors that affect the production and consumption of fuelwood in Greece. In particular, key factors responsible for the reduction in forest productive capacity and, consequently, fuelwood production include: a) the rapid urbanization of the population; b) the non-existent or inadequate cultivation and care of forest stands; c) the pressures from livestock farming and uncontrolled grazing; d) illegal clearing and seizure of forest lands; (e) improvements in transport infrastructures; (f) the spread of urban planning to the countryside and urban sprawl; (g) illegal housing and, also, legal building activities.

In addition, key factors that affect fuelwood consumption are: (a) socio-economic conditions and demographic changes; (b) technological developments; (c) the type of consumer residence; (d) household size; (c) consumer living standards; (d) environmental constraints; (e) the economic crisis; and (f) the country's international economic relations.

Deep awareness of these factors is a valuable tool for implementing more effective forest and energy policies. Energy saving will benefit the economy and help fulfill the country's environmental obligations; it is more than obvious that the adoption of effective measures and strategies constitutes a crucial factor for achieving Greece's energy and climate change goals.

Thus, proper planning in the sectors of fuelwood and forest energy in general must satisfy the following key elements in order to be more effective: 1) clear definition of objectives; 2) assessment of current and future demands; 3) evaluation of natural resources currently available; 4) research on the methods through which the objectives can be met; 5) selection of appropriate efficiency plans; and 6) determination of priorities and implementation of efficiency plans bearing in mind the risks and uncertainties entailed in such plans [2].

Necessary measures that can contribute to the efforts to maintain and, even better, increase the productive capacity of Greek forests so that we may eventually have more fuelwood production and supply are:

1. Cultivation, conservation, upgrading and improvement of existing forests and woodlands aiming at their exploitation on the basis of the principles of sustainability and multiple use in order to increase wood production.
2. Implementation of a national afforestation and reforestation program both for a future increase in wood production and for environmental reasons.

3. Making the best possible use of European programs and providing financial incentives to farmers for the afforestation of their land.

4. Developing, creating, and promoting the cultivation of fast-growing forest species for wood production (e.g., wild cherries, poplar, walnut, maple, various plane species, etc.).

5. Development and implementation of effective methods and systems to substantially improve forest protection from fires, with emphasis both on prevention and the development of more efficient forest fire extinguishing systems.

6. Adoption of suitable legislative arrangements for the protection of forests against clearing and encroachments, as well as completion of the national cadastre and development of the necessary forestry development programs.

With regard to fuelwood consumption, it has been shown that the domestic sector has a high energy-saving potential, for instance through energy retrofits of homes and through subsidies for the acquisition of fuelwood heaters of high thermal efficiency. What is more, the exploitation of logging residues and debris from the production of evergreen broadleaf shrublands will normalize the supply and demand for fuelwood to the ultimate benefit of forests, consumers, and the national economy.

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