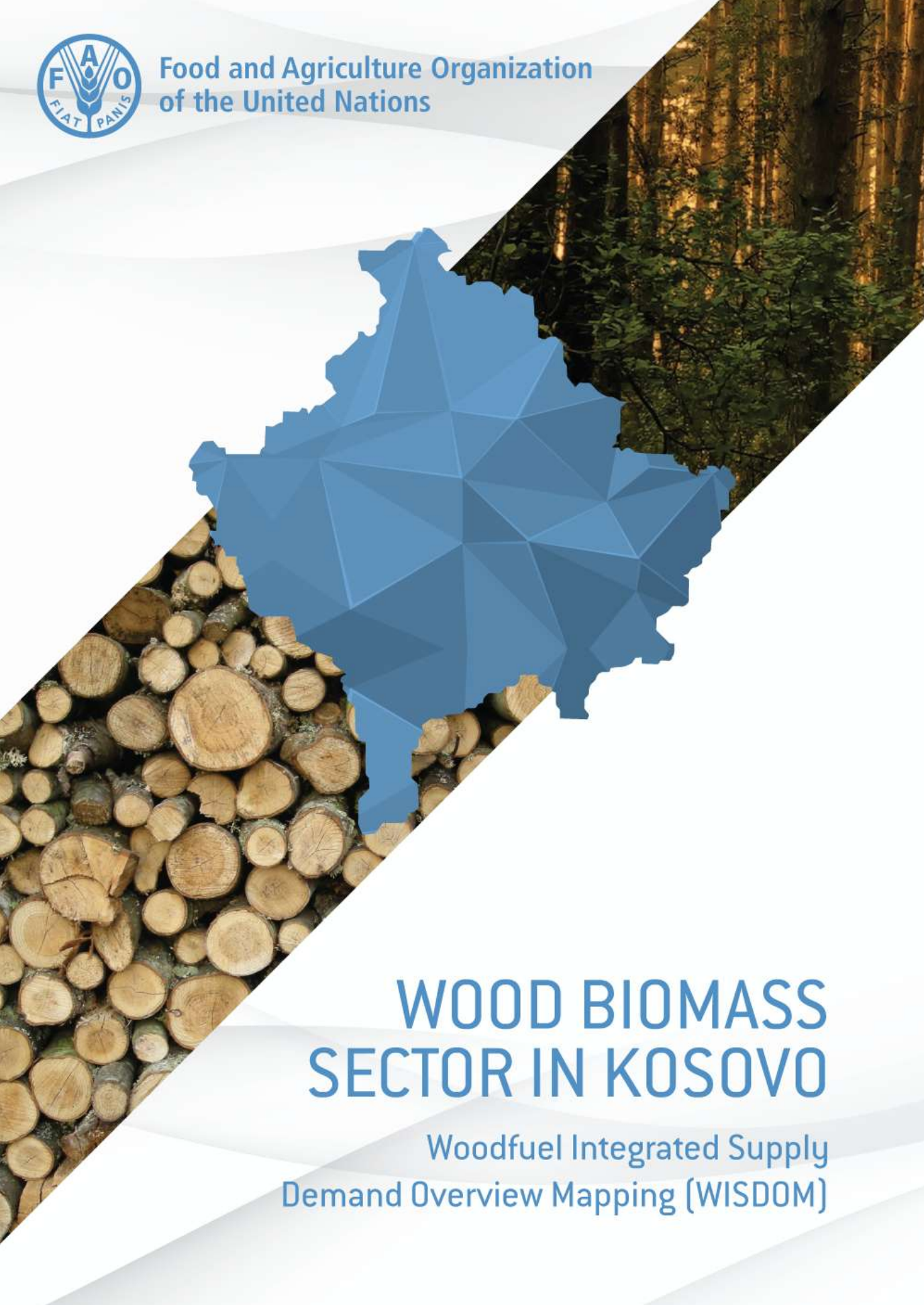**Food and Agriculture Organization of the United Nations**

WOOD BIOMASS SECTOR IN KOSOVO

Woodfuel Integrated Supply
Demand Overview Mapping (WISDOM)

WOOD BIOMASS SECTOR IN KOSOVO[*]

Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM)

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[*]*References to Kosovo shall be understood in the context of United Nations Security Council Resolution 1244 (1999)*

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FOREWORD

Wood energy is often overlooked in national planning and forest and energy due to its complex cross-sectoral charecter and fragmented insitutional competiticies across the energy, forestry, agriculture, and rural development sectors.

To address this issue, FAO in cooperation with Institute of Ecology of the National University of Mexico, has developed the Woodfuel Integrated Supply and Demand Overview Mapping (WISDOM) methodology.

WISDOM is a planning tool that identifies the specifics of the national wood energy systems and integrates relevant socio-economic information and data on wood fuel production and consumption. In addition, WISDOM is an effective tool for increasing awareness, especially to policy makers, of the complex issues surrounding wood energy.

In several countries WISDOM has contributed to the development of a comprehensive understanding of wood energy related priorities. The results of WISDOM Kosovo open the prospects of developing a holistic vision and a clear definition of priorities related to wood energy, formalizing wood fuel trade, as well as streamlining the collection and analysis of information on wood fuel demand and supply.

Kosovo WISDOM was made possible by the Government of Finland through the generous funding of the project "GCP/KOS/005/FIN - Support in Implementation of the Forest Policy and Strategy in Kosovo".

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Acknowledgments

List of Abbreviations

AUK - American University of Kosovo

CENR - Centre for Energy and Natural Resources

CLC - CORINE Land Cover

DEM - Digital Elevation Model

FAO - Food and Agriculture Organization of the United Nations

GIS - Geographic Information Systems

KFA - Kosovo Forestry Agency

KSA - Kosovo Standardization Agency

MAFRD - Ministry of Agriculture, Forestry and Rural Development

NFI - National Forestry Inventory

OSCE - Organization for Security and Co-operation in Europe

WISDOM - Woodfuel Integrated Supply and Demand Overview Mapping

Summary

Wood as a fuel is one of the most important energy sources in Kosovo's households. For a better understanding of the wood biomass sector in Kosovo, different actors were surveyed about available supply and current demand. The surveys are part of the wider activities implemented in the project "Support to Implementation of the Forest Policy and Strategy in Kosovo" (GCP/KOS/005/FIN). The project aims to increase the contribution of the forestry sector to the national economy through sustainable use of forest resources, while accounting for the multiple demands placed onforest resources. These demands include economic, social and environmental benefits, as well as the contribution to climate change mitigation.

The data collected was used to estimate the wood biomass supply and demand through the WISDOM model. WISDOM Kosovo has been implemented by using the special methodology developed by FAO described in this report. The WISDOM methodology provides harmonization and grouping of all available information related to supply and demand of wood biomass at the lowest possible administrative level.

To create the supply-side picture, information from the National Forest Inventory and other existing databases with data on biomass potential, quantities and spatial distribution of wood biomass in Kosovo were used. Secondary data collected also included inputs from statistical year books, existing road infrastructure, settlements, characteristics of the terrain, protected areas and other spatial and time related analyses. Demand for wood biomass was surveyed and mapped by administrative areas to assess the current consumption of woody biomass in the various sectors. The sectors that were covered were households/residential, public and industrial sectors.

The results of the analysis identify potential zones for investments in wood fuel production. The outputs of the analysis are in the form of complex maps, which indicate areas of concern or opportunity for the sector. Visualisation (mapping) of all relevant segments of consumption of wood as fuel, as well as of supply sources, communicates the complex relationships of the supply and demand in an easy to understand form.

1   INTRODUCTION

1.1   Backgroundand objective

The project "Support to Implementation of the Forest Policy and Strategy in Kosovo" GCP/KOS/005/FIN aims at increasing the forestry sector's contribution to the national economy through sustainable use of forest resources while meeting various demands on the forest resources. These demands include economic, social and environmental benefits, as well as contributions to climate change mitigation. The scope of the project focuses on three areas of intervention: to provide institutional support for the implementation of forest policies and strategies, to introduce integrated forest management practices, and to define mitigation measures regarding climate change within the sector.

In order to understand the current situation of the biomass market and to gauge the future outcomes of these interventions, several stakeholders in the forest sector in Kosovo were analysed. To assess demand from these stakeholders, the analysis of the wood biomass sector was divided into the following actions:

1. Household consumption: The purpose of this study was to determine the consumption of wood fuels by households and the extent of wood fuel resources in the average household's energy balance. Wood biomass is an important resource for heating throughout Kosovo. However, previous analysis of the demand for wood fuels has been limited.

2. Wood fuel consumption in the public and commercial sectors: The specific goal of this action was to collect and analyse data about wood fuel use in the public sector and in selected parts of the commercial sector. There was data specifically collected about use of woodfuels in schools, tourism related activities, and the wood processing industry. This analysis gives a new insight into wood fuel consumption in Kosovo.

3. Woodfuel Integrated Supply and Demand Overview Mapping (WISDOM) for Kosovo: Data collected from the first two activities was then merged into a model which maps the spatial supply and demand functions for wood fuels, called theWoodfuel Integrated Supply and Demand Overview Mapping (WISDOM). The WISDOM model has been applied in Montenegro and Serbia in order to better gauge the demand for biomass in the region. The WISDOM database will help Kosovo Government institutions to overcome the lack of relevant data and information on potential, consumption and contribution of woody biomass in reaching national targets for environmental and energy regulation. Additionally, the model will increase the understanding and capacity to combat climate change in the forestry sector at the Ministry of Agriculture, Forestry and Rural Development.

The purpose of this study was to get a realistic picture of wood biomass sector in Kosovo. Realistic overview and proven WISDOM methodology can be used as a basis for policy decisions and planning activities for utilization of wood biomass energy potential in Kosovo.

2 MATERIAL AND METHOD OF WORK

2.1 Woodfuel Integrated Supply/Demand Overview Mapping

The "Woodfuel Integrated Supply/Demand Overview Mapping" (WISDOM) model is a spatial-explicit method for highlighting and determining priority areas of intervention and supporting wood energy/bioenergy planning and policy formulation (http://www.wisdomprojects.net). The creation of WISDOM Kosovo follows the WISDOM principles developed by Rudi Drigo, International WISDOM Specialist and WISDOM team at FAO. The WISDOM model has been used as a strategic planning tool to that integrates statistical and spatial information for the wood fuels market with user-friendly outputs.

The WISDOM methodology uses the following steps to collect and analyse the data:
1. Setup of a national Geographic Information System to integrate all datasets available;
2. Prepare a wood energy geo-referenced database;
3. Prepare the methodologies for the development of wood energy maps and other planning tools using wood energy production and consumption information;

The data needed for the WISDOM methodology are grouped into four sets, which cover administration management, physical stock related to the supply of wood fuels, market and consumption related data, and a market balancing dataset. The first three datasets are comprised of data collected from the field and recalculations of this data, while the fourth dataset derives from comparative analysis. The data needed to run the model is as follows,
1. Administrative data/spatial plan: Municipality number and name; population; areas; transport infrastructure, etc.
2. Potential related data: Forest supply; total standing volume and increment; annual allowable cut and its structure; standing volume from agricultural sector; timber residues from wood processing industry;
3. Woodfuel demand/consumption related data:Population/number of households using firewood/wood fuel;estimated annual consumption of fuel wood in public sector and part of the commercial sector.
4. Data integration - results: Balance between consumption and supply.

Overview, harmonization and grouping of all available information on supply and demand for wood biomass as fuel, has been done at municipality level. The municipality represents the common spatial unit which all datasets are aggregated to.

2.1.1   Administrative data

For national-level studies, the analysis should be carried out at the lowest administrative level for which demographic, social and economic parameters are available, i.e. the municipality. The subnational level of analysis is an essential feature of WISDOM as it helps to avoid the aggregations and generalizations that so negatively affect wood energy studies (R. Drigo, O.R. Masera, and M.A. Trossero 2002). The administrative data used for Kosovo was aggregated to municipal level, but raster data of biomass supply and demand was initially completed on medium-resolution raster data, at the 50 m cell size, which covers approximately 0.25 hectares of land. The extent of this raster cell size provides sufficient spatial detail and due to the smaller size of country, the file size and the complexity of the data processing was manageable from a computing stand point. Additionally, the 50 m raster data supports enough detailed spatial analysis to make the information adequate for strategic planning and local operational planning.

In order to determine the areas that had forest cover, a CORINE land cover map was obtained from the Ministry of Agriculture, Forestry and Rural development (MAFRD). CORINE Land Cover (CLC) is a geographic land cover/land use database encompassing most of the countries of Europe, which uses satellite and ancillary data to determine land use in a set of given categories. The minimum mapping units correspond to 25 hectares per 100 m (G. Büttner et al. 2012). This GIS data delineates forests from other land uses and was used for additional land cover analyses that may provide biomass for energy consumption (e.g. supply parameters coming mainly agricultural land uses, such as vineyards). The owner of the data is European Environment Agency (http://www.eea.europa.eu/).

Forest resources are also potentially difficult to access; therefore, in order to better represent the costs of harvesting wood fuels from higher or mountainous elevations, an additional layer of GIS data was constructed, using the official 50m digital elevation model data (DEM). The infrastructure digital elevation model (DEM was used to develop a scenario of how to maximize forest accessibility with most cost-effective means. This was the basis for making a slope map for the whole Kosovo using advanced ArcGIS extensions and the feature *SLOPE.* To measure the transportation distances and calculate costs, a map of all roads was obtained from MAFRD. The layer has 7 697 line objects (roads) with total length of 10 514 kilometres of roads throughout the country.

For the population parameters that would determine the demand for biomass, the basis for mapping areas of each settlement was a vector map of settlements. This GIS data included 1 245 records, with information on population in each vector (1 734 000 inhabitants),(MAFRD, Statistical office). These population areas can be found in Figure 1.

Figure 1. Settlement map of Kosovo

2.1.2   Supply module (data related to potential)

The supply module provides a spatial representation of all wood fuel sources, their stocking capacity, their change over time and their productive capacities (R. Drigo, O.R. Masera, and M.A. Trossero 2002). Although there are different types of potential biomass available for energy consumption in Kosovo, the forests are the most important direct source for the WISDOM supply module. Other sources of biomass were also included in the supply

module from other land use categories (i.e. vineyards) and wood wastes from wood processing industries were also estimated in the following sections.

2.1.2.1   Forest cover

An initial review for all available vector maps delineating forest and forest areas from other land cover categories was done. Two spatial datasets were available for consideration; namely, the National Forestry Inventory (NFI), which had a spatial cell size of 2x4 and 4x4 km grid and the CORINE land cover map from MAFRD, with the smallest mapping unit of 25 hectares. The estimated area of forests varies based on dataset from 39.6 percent (CORINE) with 8.8 percent in other forest land (e.g. transitional woodland-shrub) to 44.7 percent (NFI 2012).

2.1.2.2   Wood processing industries

Wood processing industry is also an important source of wood biomass available to homes for heating (beside forests). Data was collected through interviewing firms in the processing wood industry. The purpose of the interviews was not to study wood processing activities in Kosovo in detail, but to get the number of companies operating and the quantities of wood waste available in Kosovo. Although there may be other smaller processing facilities that have available wood waste, this study focused solely on sawmills.

The Ministry of Agriculture, Forestry and Rural Development (MAFRD) provided a list of licensed sawmills. There were 51 sawmills with MAFRD approved licences in 2014, all of which were visited for the study. However, only 40 sawmills were interviewed for supply potential, as 11 were passive or not in operation. Data from interviewed sawmills was collected using a unique survey instrument. The survey instrument contained questions that covered: Amount of wood processing during the year 2012 and the type of wood (Coniferous or Deciduous), the amount of wood waste, the use of such waste and production of wood fuels, such as pellet, briquette, wood chips etc.

Licensed sawmills are only a proportion of the total sawmills operating in the country. Therefore to obtain more comprehensive picture on the sector, assistance from Kosovo Forestry Administration (KFA) was needed. The KFA forest inspectors provided data for 42 additional sawmills in six regions. This data was less consistent compared to the data obtained from MAFRD and provided only a broad picture on the decline of the wood processing sector.

2.1.3   Demand module (wood fuel demand/consumption related data)

The demand module portrays the spatial distribution of wood fuel consumption, disaggregated by fuel type (fuelwood, charcoal, others), by sector of users (households, industrial, others) and by area (rural, urban) (R. Drigo, O.R. Masera, and M.A. Trossero

2002). In order to assess the demand for wood biomass for the Kosovo WISDOM model, consumption of woody biomass for energy in the various sectors was surveyed and mapped to the administrative areas. The estimation of the consumption of woody biomass covered the households/residential, public and the industrial sectors.

2.1.3.1 Use of wood biomass byhouseholds

The household sector consumes approximately 48 percent of the total energy in Kosovo, with 45 percent coming from biomass and 44 percent coming from electricity (EPTISA and World Bank 2013). According to the 2011 Census, in Kosovo 1.74 million people[1] live in approximately 293 078 residential dwellings, resulting in an average of 5.9 occupants per dwelling (KSA 2011). The northern Serbian communities, Zvecan, Leposavic, Zubin Potok and the northern part of Mitrovica, did not participate in the 2011 Census but they are estimated to have approximately 70 430 people (OSCE 2014). Assuming that the northern communities have four persons per household, this study estimates that there are 363 508 households in Kosovo. The rural-urban demographics indicate that 38 percent (661 586 people) of the population lives within urban areas. Urban households account for 43 percent (128 131 households) of occupied residential dwellings. The rural-urban split and the number of household members will likely influence the consumption of wood fuels.

To estimate the total household consumption in rural areas of Kosovo, a survey was undertaken in 2013. The survey was undertaken by the RIT/AUK Centre for Energy and Natural Resources (CENR). The CENR used an individual household interview research methodology to conduct 1 160 surveys of rural households around Kosovo (hereinafter referred to as the Rural Survey). These results were combined with existing CENR survey data, from a similar study conducted in 2011 in urban areas (hereinafter referred to as the Urban Survey). In order to sample a representative rural population for the 2013 Rural Survey, from the 27 municipalities 121 villages the 1 160 households were randomly chosen based on the size of the municipality respective to the total population, Table 1. GIS maps were then used to randomly sample villages within the municipality and each village needed a minimum of 10 completed surveys. Surveys were administered to every third house until the total number of surveys was collected in the village. Villages from the municipalities located around mountains, away from major towns and lacking infrastructure were identified as remote villages, given that these villages may have less alternative heating options than wood fuels.

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[1] This number excludes the Serbian populations in the north of the country that were not surveyed by the Census. Information corresponding to these populations were found in (OSCE 2014), though it does not include the same detailed information as the Census for households.

Table 1. Number of surveys per municipality from the 2013 Rural Survey

Municipality	Number of surveys completed
Deçan/Dećane	37
Dragash/Dragaš	27
Ferizaj/Uroševac	51
Fushë Kosovë/Kosovo Polje	45
Gjakovë/Djakovica	43
Gjilan/Gnjilane	36
Gllogoc/Glogovac	47
Istog/Istok	35
Kaçanik/Kaćanik	42
Kamenicë/Kamenica	38
Klinë/Klina	30
Leposaviq/Leposavić	44
Lipjan/Lipljan	45
Malishevë/Mališevo	44
Mitrovicë/Mitrovica	34
Pejë/Peć	37
Podujevë/Podujevo	69
Prishtinë/Priština (rural)	61
Prizren	72
Rahovec/Orahovac	48
Shtime/Štimlje	21
Skenderaj/Srbica	41
Suharekë/Suvareka	43
Viti/Vitina	39
Vushtrri/Vućitrn	55
Zubin Potok	32
Zveçan/Zvećan	44
Total	**1160**

The Urban Survey had a sizeable difference in the number of households surveyed, in order to proportionally adjust the survey respondents, a sample of 259 households was randomly drawn from the Urban Survey dataset (Table 2). The merged data set consisted of 1 160 questionnaires from the Rural Survey and 259 questionnaires from the Urban Survey (2011). The two survey instruments varied slightly in the number of questions and exactly how some of the questions were asked. Therefore, when merging the two datasets some of the variables were converted to common units.

Table 2. Number of surveys for the six municipalities from the 2011 Urban Survey
and the 2013 Prishtina Survey

Municipality	Number of surveys completed
Ferizaj/Uroševac	28
Gjilan/Gnjilane	37
Gjakovë/Djakovica	28
Pejë/Peć	38
Prizren	55
Mitrovicë/Mitrovica	30
Prishtinë/Priština (town)	107
Total	**295**

2.1.3.2 Use of wood biomass in schools around Kosovo

Data on fuel consumption for heating school buildings was gathered from the Municipal Offices for Education in Kosovo's 32 municipalities. According to the official data from the Ministry of Education, Science and Technology, the total number of schools in Kosovo is 1 154, which includes all public kindergartens, primary schools, secondary schools and schools for children with special needs. Responsible persons at Municipal Offices for Education were contacted and asked to submit data about fuel consumption for all education buildings in their respective municipalities. After several meetings, the data for 1 087 educational buildings was collected, which covers 94 percent of schools across the country. The data obtained for this study from the Municipal Office for Education included the following: school name, address, the total surface area, year of construction, type of fuel for heating, the heating system, the amount of fuel used in 2012 and the total cost (EUR). One limitation regarding the data collected was that for some municipalities the data is not complete and the data about fuel consumption is missing.

2.1.3.3 Use of wood biomass in tourist facilities:

Demand for wood fuels also comes from businesses in the tourism industry. From Business Registration Agency we obtained the data on the official number of registered tourist facilities throughout Kosovo. Based on the total number of 5295 registered tourist facilities in the Business Registration Agency (Ministry of Trade and Industry), the study sampled 253 tourist facilities which included hotels, restaurants and pizzerias, bakeries and fast food. The sample used in this study represents 5 percent of all registered tourist facilities.

Depending on the size of municipality and density of tourist facilities, in each municipality 5-10 tourist facilities were interviewed. At each tourist location, the data was collected from either the owner or the main manager using the questionnaire. Some of the questions included were the type of fuel they use for heating and food preparation, the amount of fuel and its cost, and source of wood fuels and heating system. To minimize the

cost of sampling and the data collection, the inquiry was done in the field at the same time as collecting data on fuel consumption in schools and the wood processing industry.

2.1.4   Wood fuel producers

During the inquiries into who uses wood fuel in Kosovo, additional data about wood pellets, briquettes and charcoal producers was collected. These businesses are both direct users of wood fuels from forests and suppliers to end-use consumers. Currently there is no official listing of wood fuel producers, thus it was decided that the information about wood fuel producers would be collected throughout the country. This information was collected in parallel to the information collected from thewood processing industry and the consumption in tourist facilities. The information on these wood fuel producers was gathered from forest experts working at Kosovo Forestry Agency and from other relevant stakeholders. Among wood fuels, only fuels that are not very common, such as pellets, briquettes and wood chips have been considered.

3   SUPPLY MODULE

3.1   Direct sources

3.1.1   Forests

The forests of Kosovo are an important national resource. Kosovo's official land area is 1 090 800 ha of which at approximately 481 000 ha is covered by forests (44.7 percent). A total of 180 800 ha (38 percent) of Kosovo's forest is classified as privately owned, and 209 200 ha (62 percent) classified as public forest. In Kosovo there are two forest areas that have been designated by the government as national parks: Sharri in southern part of Kosovo (17 600 ha) and Bjeshket e Nemuna in western part of Kosovo (42 000 ha). Both national parks are located in high elevation forested areas. According to the Law, the forests, regardless of classification, should be managed so that they can provide a sustainable production and at the same time protect the biodiversity for the benefit of existing and future generations.

Coppice forest covers 84 percent of the total forest area. Kosovo's forests are dominated by broadleaved trees, covering 93 percent of the forest land (449 400 ha). Coniferous forests cover almost 5 percent of the forest area (23 800 ha), and are evenly distributed between the various structure classes. In total, 50 percent of the forest area is considered even-aged (Kosovo NFI, 2012).Main species in Kosovo forests are: *Fagus sp*; *Quercus sp*; *Abies alba*, *Picea abies* and *Pinus sp*.

According to the NFI data, the growing stock of trees with diameter at breast height that is greater or equal to 7 cm, stands at 40.5 million m^3, which is approximately the same size as ten years ago. Annual increment over bark (NFI 2013) of trees with diameter (dbh) greater or equal to 7 cm is estimated at 1.55 million m^3 – 1.32 million for the broadleaves category and 0.23 million for coniferous trees. In comparison, the average growing stock in Kosovo is 84 m^3per ha. The average increment in Kosovo is 3.2 m^3per ha.

Harvests should take place in forests that are technically suitable for harvesting taking account of themultifunctional role of forests. These forests are defined by UNECE/FAO and Forest EUROPE/MCPFE in the document "Forests available for wood supply." In order to determine forests available for wood supply in Kosovo, the following limitations have been considered:

- Inaccessible forests should not be considered;
- Forests in national parks should be excluded (following the current regulations);
- Forests with other legal or natural harvesting restrictions should be excluded;

Within the NFI project, the maximum long-term annual harvest, strictly from a productivity point of view, is approximately 1.45 million m^3. This is a gross figure and should be reduced due to harvesting losses, natural losses and environmental considerations. The net maximum long-term annual harvest level for Kosovo is 1.2 million m^3. It is recommended that this estimatebe further reduced due to areas unavailable for wood supply, including National Parks (NFI 2013).The actual cut in the forests was estimated to affect 60 percent of the forest area from the NFI project. Consequently, the real annual harvest was roughly estimated to be 1.6 million m^3 annually. From the NFI study, only a small fraction of the harvesting (7 percent) was carried out in compliance with the current forest legislation.

This low level of regulated harvests needs to be further considered, including many factors that contribute to the issue (Radicevic et al. In Press). In 2012, the planned annual cut in public forests was 141 518.52 m^3. In 2013, this number was increased to 148 857 m^3. None of the targets were fully met, and MAFRD/KFA report that only 35 496.27 m^3 in 2012 and 21 286.82 m^3 in 2013 of firewood, technical wood and wood by-products were collected (MAFRD, 2013b). According to MAFRD's Annual Progress Report for 2013, the reasons behind this low realized cut were the approvals of National Park Laws, low economic operator interest and delayed municipal tenders. As far as private forests go, the same trend of reduced harvesting was observed, from 158 839 m^3 in 2012 to 141 473.69 m^3 in 2013. No explanation was offered for this reduction in private forests (MAFRD, 2013b).

At national level, it seems that annual removals and natural losses of wood are balanced by gross annual increment. Based on the share of degraded high forest and results from recent forest management planning, in certain areas over-harvesting has taken place (NFI 2013).

Based on the CORINE land cover maps and the NFI, coupled with the information on the direct sources of wood fuel stock available at different diameters, Figure 2 was created.
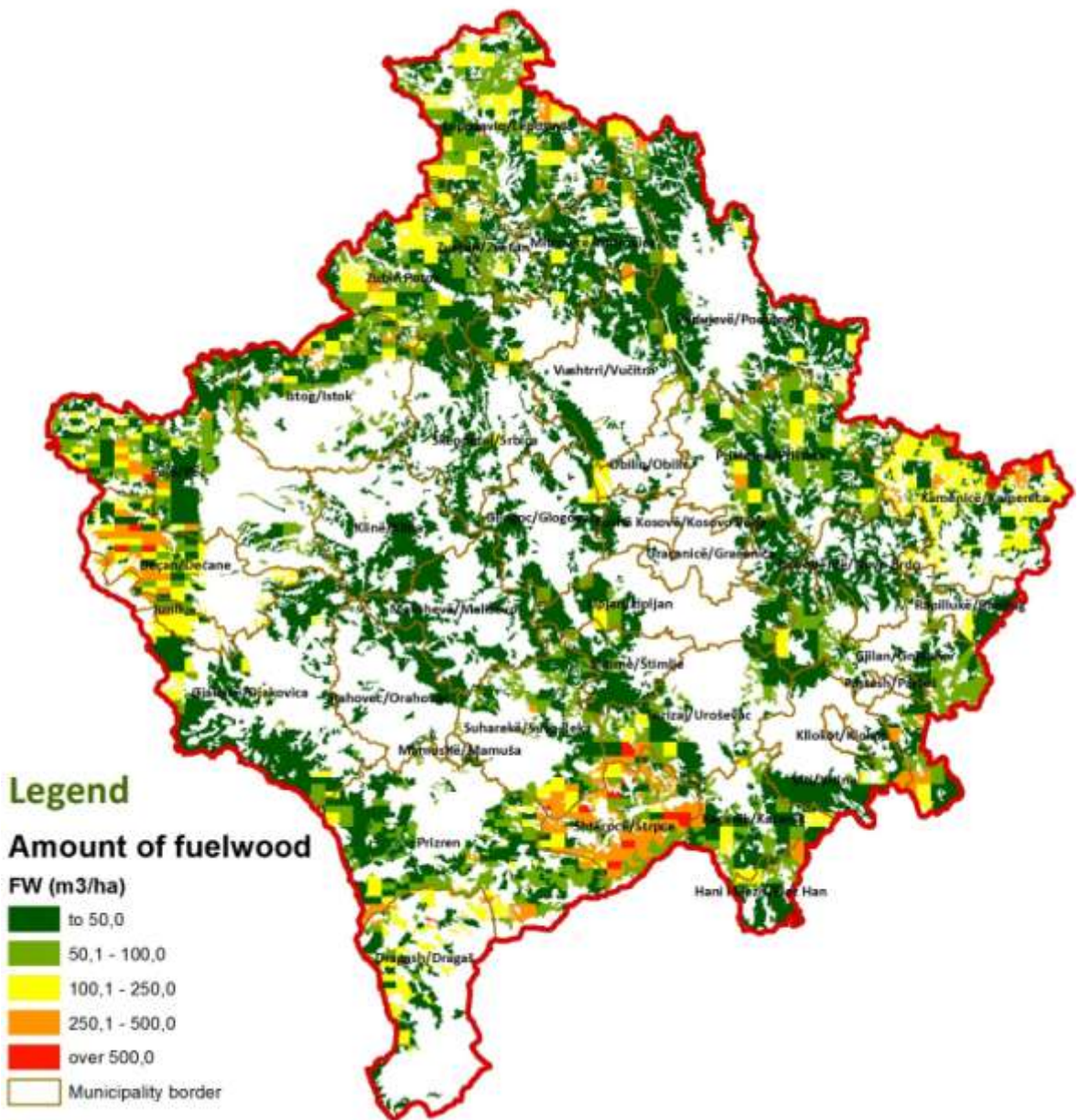
Figure 2. Estimated amount of current amount of biomass for energy

3.1.2   Woody biomass residues from vineyards and orchards

Outside of wood fuel provided directly by the forests, biomass that can be used for heating may come from other agricultural activities. In order to estimate the quantity of woody biomass, residues from vineyards and orchards was estimated and mapped based on the following data:

- CORINE Land use map, which allows to locate the agricultural area dedicated to vineyards, and orchards (EEA, 2006),
- Biomass potential data (Drigo, 2011).

Based on insights from past surveys (analysis done in Slovenia, Drigo at all. 2006) and land cover in these other biomass producing sectors, the total potential of woody biomass residues from non-forest land in Kosovo amounts to 7501 tonnes per year.

3.2   Indirect sources

In addition to wood fuel sources coming directly from forests, additional quantities of biomass may be available through indirect sources. These sources are important when considering the balance between the supply and the demand for biomass in Kosovo. Indirect sources include wood biomass from the sawmill industry and from entities that process wood into value-added fuels like pellets, briquettes and chips.

3.2.1   Sawmill industry

Data on the sawmill industry was gathered in two steps. Primarily, only data was gathered by interviews in the field from licensed sawmills. Staff from 40 sawmills were interviewed based on the information obtained from MAFRD. A second set of data was collected from the KFA Forest Inspectors on unlicensed sawmills throughout six municipalities (this data was not very detailed). In order to protect the confidentiality of the data sources, the information was aggregated to the municipal level. The number of sawmills and their estimated quantities of wood processed in 2013 can be found in Table 3. Based on the information gathered in the field, it appears that the officially licenced sawmill industry is in decline. For the illegal industry, it is difficult to accurately collect data about production and the volume of round wood that is processed annually. Officially, sawmills processed less than 50 000 m^3 of logs in 2013. It is estimated that of the quantity of roundwood processed less than 50 percent is coniferous, and more than 70 percent of volume of roundwood is imported.

Table 3.   Number of sawmills and estimated production by municipality

N	Region	Data gathered with questioners		Data obtained by inspectors	
		Number	Quantity of wood processed in 2013 (m^3)	Number	Quantity of wood processed in 2013 (m^3)
1	Prishtinë/Priština	3	580	7	1500
2	Mitrovicë/Mitrovica	8	10200	17	15000
3	Pejë/Peć	17	10550	31	20000
4	Prizren	2	2050	3	3520
5	Ferizaj/Uroševac	6	1850	9	6000
6	Gjilan/Gnjilane	4	1480	10	3500
	Total	40	26710	77	49520
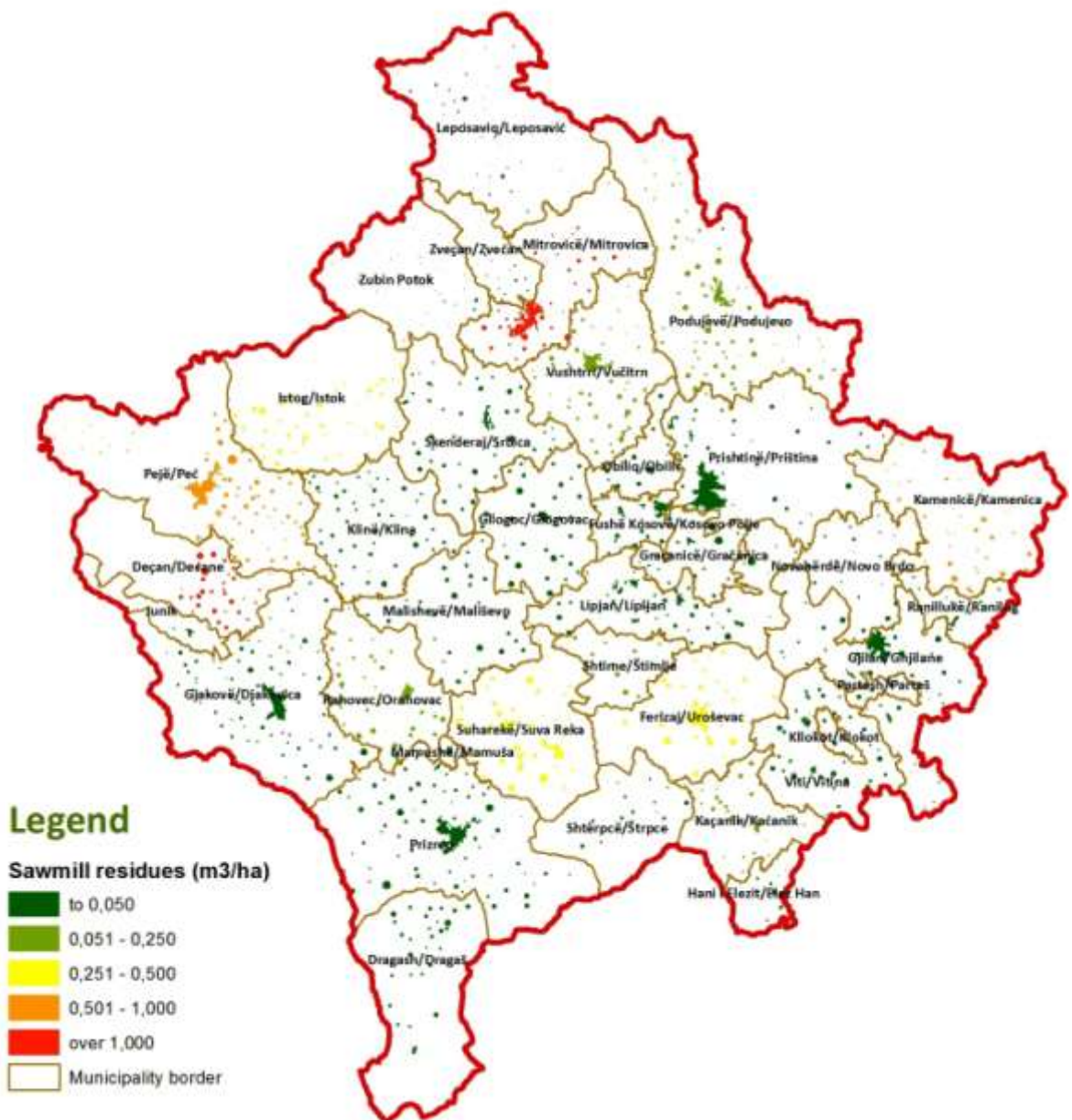
Figure 3. Estimated location of biomass residues in Kosovo

Based on the estimated residues from vineyards, orchards and sawmills, the supply from these sources was mapped and prepared for the WISDOM model (Figure 3).

3.2.2   Wood fuels production in Kosovo

Through different information sources, three briquette producers, five pellet producers, one chip producer and three charcoal producers were identified to be operating in Kosovo. The total production of pellets for the five producers was estimated as 20 500 tonnes annually (Table 4), the biggest producer is producing 14 000 tonnes and it is located in Peja. Production of briquettes was much smaller, producing 5 100 tonnes. Based on the information collected in the field, the pellet market is growing in terms of producers and users. The briquette market is significantly smaller, more stable, and more locally orientated. While investigating the potential growth of the pellet industry, the Customs Office indicated that wood pellets are being imported, a market that domestic supply could potentially displace. In regards to charcoal production, the market is locally specific and used mainly in local tourist facilities.

Table 4.   Production of wood fuels per local municipality

Municipality	Main products	Wood briquettes (Tons)	Wood pellets (Tons)	Wood chips (Tons)	Charcoal (Tons)
Kllokot/Klokot	Pellet, Briquette	3700	3700		
Kamenicë/Kamenica	Pellet		500		
Mitrovicë/Mitrovica	Pellet		1600		
Lipjan/Lipljan	Pellet		700		
Pejë/Peć	Pellet		14000	300	
Podujevë/Podujevo	Briquettes	300			
Deçan/Dečane	Briquettes	1100			
Lipjan/Lipljan	Charcoal				40
Viti/Vitina	Charcoal				10
Mitrovicë/Mitrovica	Charcoal				70
Total		5100	20500		120

3.3   Summary of the supply module

To summarize the different sources of biomass supplying the Kosovo wood fuel market, the most important source of biomass are forests and other forest land with an estimated 95 percent share. Biomass from forests includes cut of low quality wood and timber assortments, used for fuelwood, as well as cut of thin trees (below 7 cm DBH) used for fuelwood. All the other resources from vineyards, orchards, sawmills and wood fuel producers are limited and represent only 5 percent of the market. The breakdown of these sources can be seen in Figure 4. The approximate net supply available to the biomass market is estimated to be 1 320 million dry tonnes.
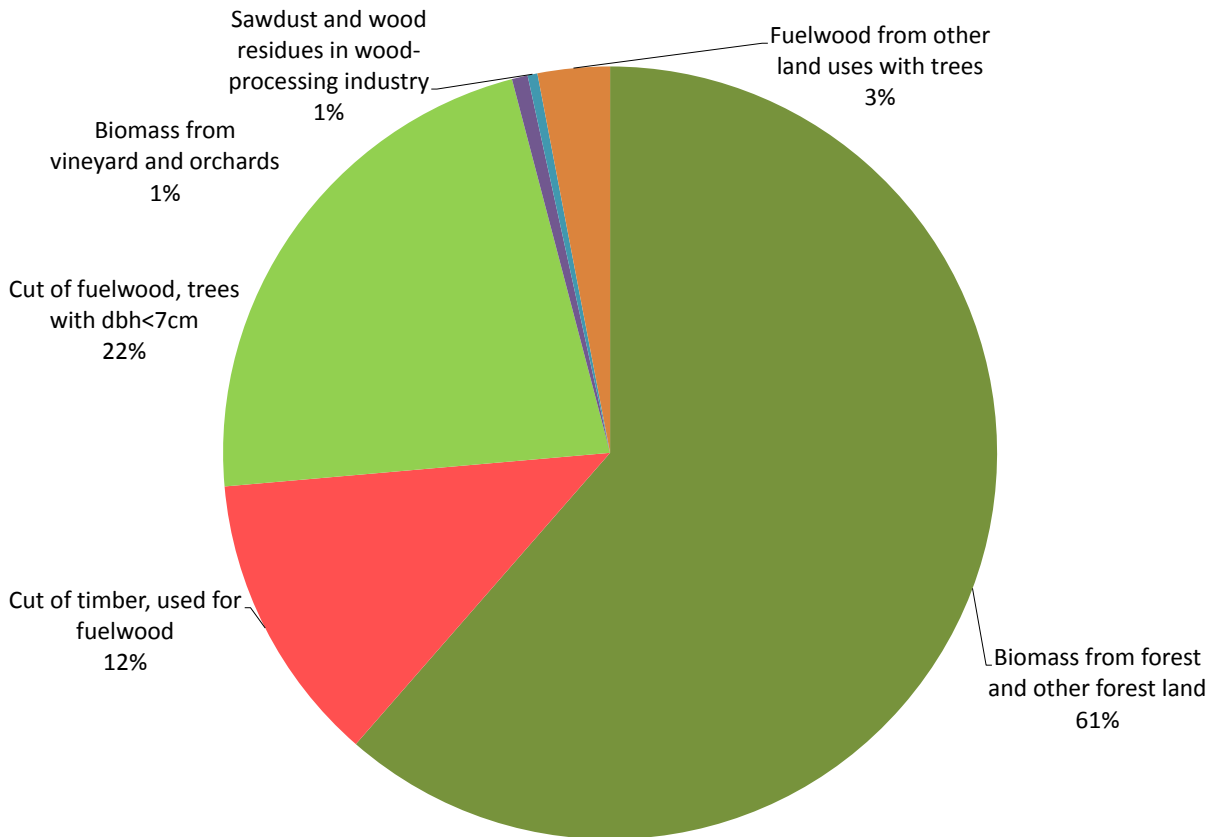
Figure 4. Structure of Biomass Supply Input for the WISDOM Model

4   DEMAND MODULE

The primary scope of the Demand Module is to assess and map the current consumption of woody biomass for energy in the various sectors outlined in Section 2.1.2. The estimation and mapping of the consumption of woody biomass covered residential, public and industrial sectors.

4.1   Residential consumption of firewood, pellets and chips

4.1.1   Surveyed rural households

When considering the factors that contribute to the amount of heated space needed for rural households, the primary factors may include surface area, the area heated in the winter heating season and the number of people living in the household. In order to determine how representative the data collected in the rural survey was, results were compared to other sources. According to the Census (2011), the average rural family size in Kosovo is 6.4; the 2013 Rural Survey shows a slightly higher average, where the mean number of family members in remote villages is 6.68, and 7.78 for non-remote villages. The average number of rooms in the surveyed households is 4.6, while the average number of rooms that are mostly used is 3.4.

The surveyed homes heat 2.28 rooms on average during the heating season (October-April). For the surface area heated on a per person basis, remote villages averaged 10.37 m^2 per person and non-remote households averaged about 9.7 m^2 per person. Remote villages had on average more surface area heated during the winter than non-remote villages, with an average area of 10.34 m^2 heated in the remote villages and 9.71m^2 heated in the non-remote villages. On average, households are heating approximately 7 to 9 percent of their total surface area. It is typical in Kosovo that households do not heat all their home space due to several factors, including cost.

As in many developing countries, households typically use more than one type of energy in order to diversify the risk in supply. In order to distil the importance of all the energy sources together, a variable was created by summing up the total costs of each energy source in order to get a total spent by the household. The average amount spent on energy in Kosovo for 2013 during the heating season was EUR 500.87, or on average EUR 83 per month. The average prices, quantities and total amount spent on energy can be found in Table 5. The remoteness of the village had little difference on the average consumption of these types of wood fuels. On average, the prices for fuel wood are cheaper in the remote villages. The larger quantities of wood and higher prices in the non-remote villages lead to a higher total cost, on average for the different fuel woods. Therefore, the average prices and quantities are reported for the entirety of the rural sample.
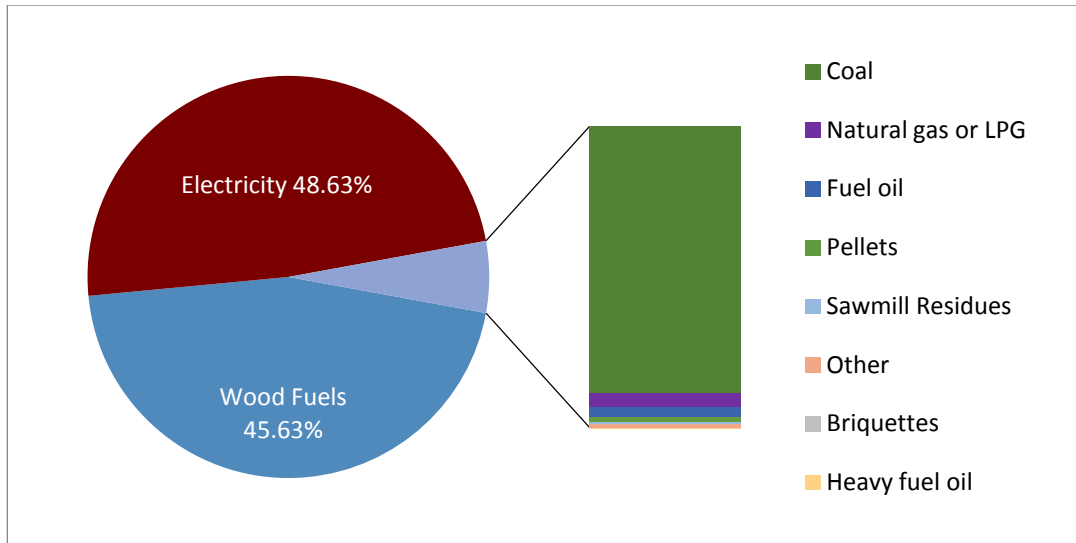
Figure 5. Aggregate energy consumption, by total Euros spent

Table 5. Average prices and quantities for different household fuels

Energy Type	Unit	N[2]	Quantity				Price			
			Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
Firewood[3] (1m long)	Stock m³	1160	8.24	4.01	2	50	24.84	13.51	0	53
Small logs (25-50cm)	Stock m³						21.60	13.36	0	40
Firewood (logs, round wood)	m³						13.74	16.07	0	75
Sawmill residues	Loose m³	5	8.40	6.07	3	15	4.00	8.94	0	20
Wood pellets	Tons	1	6.00		6	6	165.0		165	165
Other wood fuels (chips, sawdust)	Tons	19	6.58	11.38	1	50	18.00		18	18
Coal	Tons	140	6.15	3.65	1	22.0	31.99	21.33	0	140
Electricity[4]	kWh	1 040	4 887.4	4 451.6	0	97 222	417.7	462.8	17	9815
Fuel oil	Litre	4	518.00	581.49	20	1202	1.26	0.05	1	1
Natural gas or LPG	Litre	16	49.88	57.18	1	180	1.80	2.57	0.0	10

[2] Include households that indicated that they paid 0 Euro for the fuel

[3] In the 2013 Villages Database, the types of wood a household could choose to answer were: '1m Long Wood', 'Small Logs Wood', and 'Round Wood (solid wood)'. In order to convert to solid wood, the different types of wood were multiplied by 0.69, based on the UNECE average conversion factor for solid wood into wood fuels (0.65) adjusted for local conditions using expert advice (UNECE 2009). Prices varied however, by the size of wood that was purchased.

[4] Electricity prices are in block tariffs, which increase base on consumption. The average winter tariff for electricity in Kosovo in 2012-13 is 0.0505 for the block of 0-200 kWh/month consumed, 0.07 for the block of 200-600 kWh/month consumed and 0.1016 for greater than 600 kWh/month consumed, which can be found on the back of any KEDS bill or in (ERO 2012). This is calculated for the entire 7 months of the heating season.

The average consumption of wood per household was 8.24 m^3 with a standard deviation of 4.01 m^3 for the 2013 Rural Survey. The variation of average consumption throughout the country was further considered when calculating the estimate consumption for all rural areas (Table 4). Using these averages for the villages, the total number of wood consuming households from the Census and OSCE numbers is approximately 176 934 occupied rural households. Based on the numbers from the Census (KSA 2011) for households that consume wood as their primary source of energy by municipality and the differences by location within Kosovo, the results indicate a total consumption of 1.447 million cubic meters of wood fuels consumed (Table 6). Deviations from this average may be due to other household characteristics, location and other effects.

Table 6.   Estimated annual consumption of wood fuels (m^3) by rural municipality and wood consuming households

Municipality	N	Mean	Std. Deviation	Min	Max	Total [5]Number of Households (Census)	Total wood Consuming Households	Est Consumption Per Municipality
Deçan/Deçane	37	8.67	3.19	0	17	6 011	5 948	51 5789
Dragash/Dragaš	27	7.54	5.76	2	35	5 857	5 799	43 718
Ferizaj/Uroševc	51	8.83	2.50	5	17	10 452	10 282	90 838
Fushë Kosovë/Kosovo Polje	45	4.94	2.41	1	11	2 838	2 040	10 072
Gjakovë/Djakovica	43	10.06	3.76	3	21	7 865	7 757	78 044
Gjilan/Gnjilane	36	7.74	2.09	4	14	7 653	7 549	58 454
Gllogoc/Glogovac	47	5.65	2.02	2	10	7 643	7 386	41 7467
Istog/istok	35	9.32	3.66	3	21	5 724	5 639	52 583
Kaçanik/Kaćanik	42	9.55	3.16	0	17	6 205	6 128	58 492
Kamenicë/Kamenica	38	9.48	5.40	5	35	4 905	4 828	45 762
Klinë/Klina	30	7.89	3.49	2	21	4 764	4 691	37 007
Leposaviq/Leposavić[6]	44	9.27	3.81	3	21	4 725	4 725	43 791
Lipjan/Lipljan	45	7.51	3.19	3	17	8 080	7 863	59 077
Malishevë/Mališevo	44	8.88	4.83	1	30	6 398	6 295	55 874
Mitrovicë/Mitrovica	34	7.08	4.36	0	19	4 283	4 195	29 712
Pejë/Peć	37	8.99	4.48	3	21	7 847	7 741	69 581
Podujevë/Podujevo	69	8.93	3.88	0	21	9 618	9 333	83 344
Prishtinë/Priština	61	9.51	5.50	0	35	10 153	9 369	89 127
Prizren	72	8.34	4.06	2	28	11 717	11 527	96 106
Rahovec/Orahovac	48	8.63	2.90	1	17	5 839	5 775	49 809
Shtime/Štimlje	21	9.96	3.92	3	21	2 951	2 903	28 901
Skenderaj/Srbica	41	6.45	2.98	2	14	6 400	6 343	40 885
Suharekë/Suhareka	43	9.50	5.29	3	24	7 319	7 220	68 587
Viti/Vitina	39	10.07	4.17	3	21	7 101	7 012	70 589
Vushtrri/Vučitrn	55	5.68	3.19	0	17	6 861	6 514	36 979
Zubin Potok	32	7.18	2.37	0	12	3 475	3 475	24 952
Zveçan/Zvećan	44	7.45	2.55	3	14	4 250	4 250	31 658
Total	1 160	8.24	4.01	0	35	176 934	172 587	1 447 270

One important aspect of the wood fuels market is the source of the supply for the household (Figure 6). If someone collects wood fuels from their own forest, then this is wood fuel that is not traded on the market and may be managed differently. The most important types of wood fuels are firewood of one meter long and logs (round wood).

[5] The list does not include the municipalities that were merged due to small size. The information on how this was done can be found in Section 3.1
[6] These population numbers come from the OSCE municipal profiles

Concentrating only on firewood, the average contribution per household is EUR 79 per month for own consumption, using the average market price for wood fuel. To put this statistic in perspective, if the average household earns EUR 400 per month, meaning that 20 percent of household income goes to own-consumption of wood. Accounting for the internal subsidization, the estimate cost of fuel wood is approximately EUR 13.74 to EUR 24.84 per m^3, not including the households that do not pay for wood, prices ranged from EUR 28 to EUR 30.78 per m^3.
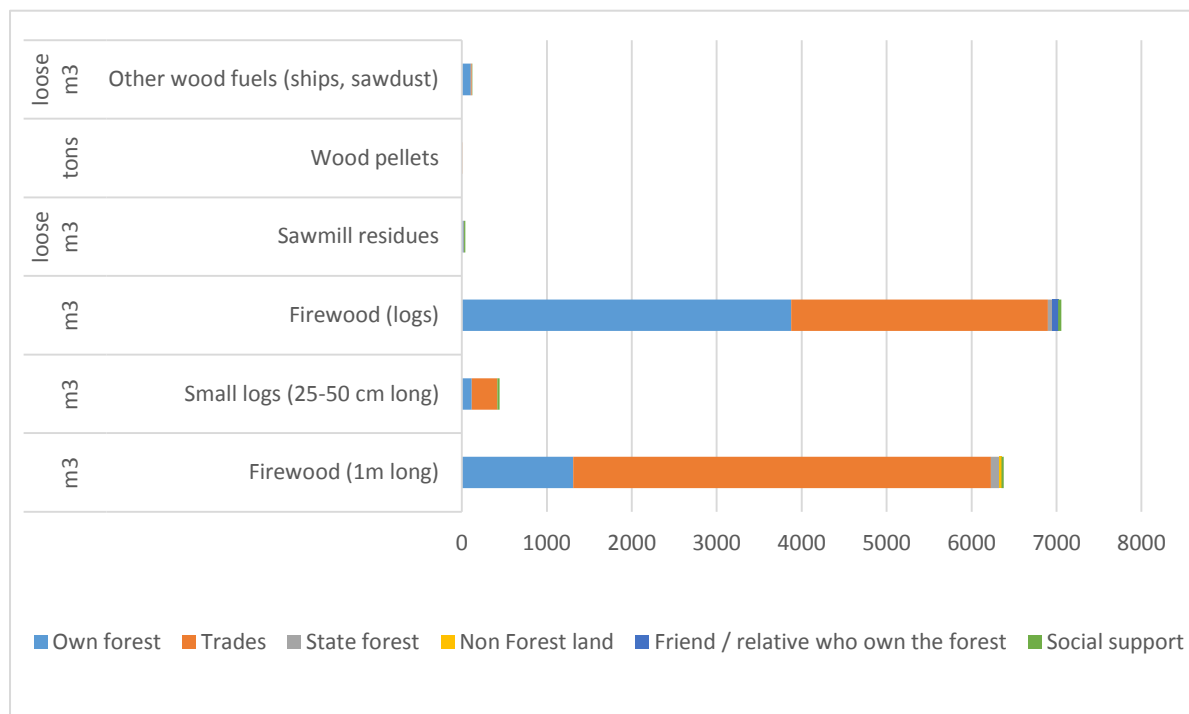
Figure 6. Quantity of wood fuels for consumption by sources and type

One aspect that might increase the amount of wood that a household consumes is the season of the wood, with different outcomes in heat and length of time that the logs burn. In order to determine whether households were using seasoned or newly harvested green wood, a question was asked about the purchasing and preparation time for harvesting wood. Dried wood typically burns hotter, while green wood typically burns longer with less total heat. The majority of firewood is typically cut or purchased two months or less before the heating season, indicating that the firewood that is consumed in households is not typically dried and thus has a lower heating value (Figure 7).
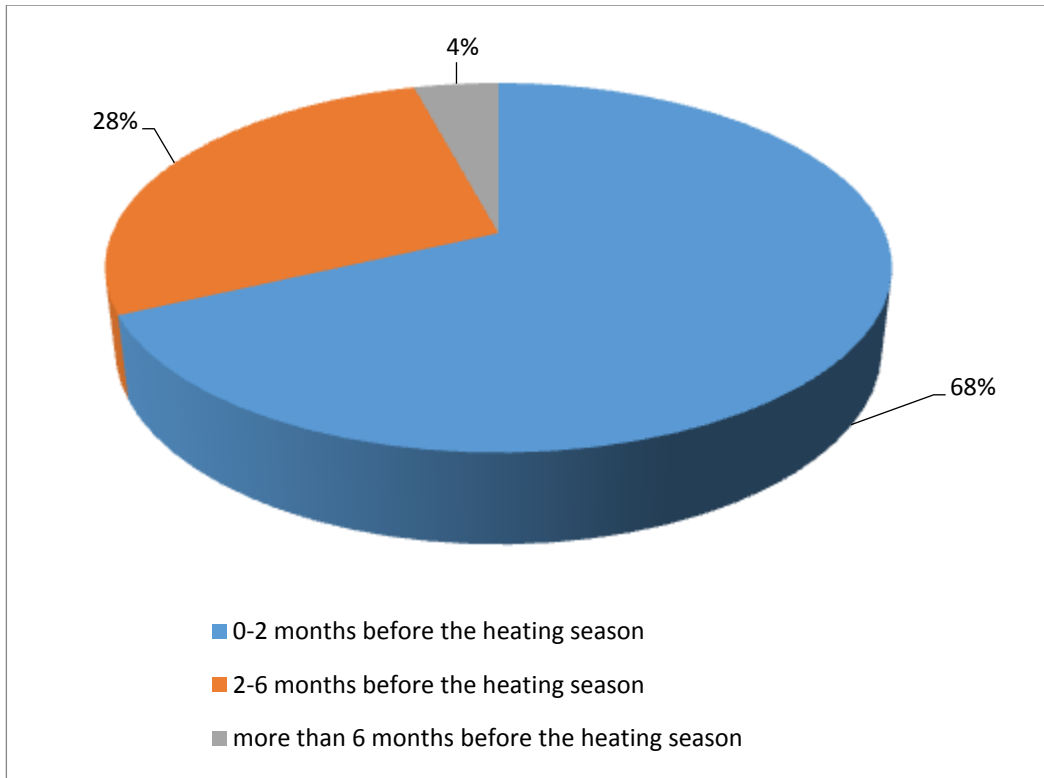
Figure 7. Percentage of time needed for preparing or purchasing wood

When asked about the timing when households consume wood fuels, 590 households (51 percent) responded all year round and 568 households (49 percent) responded only during the heating season. This implies that about half of the households in Kosovo consume wood fuels constantly throughout the year. These households have an average consumption of 8.88 m^3 of wood fuels for the year. Households that consume wood fuels only during the heating season had an average consumption of 7.61 m^3 of fuel wood. This indicates that households use wood intensively in the heating season and little is consumed during the rest of the year. In most cases those households that responded that they consume wood fuels all year round consumed a larger amount than those that consumed them just during the heating season. From Table 7, the difference in wood fuel demand can be seen by municipality and by heating season. For some municipalities, the number of people that consume firewood changes significantly between seasons and in amounts demanded. In part, this will also reflect the reliability of the electrical system in these areas, remoteness and access to forests.

Table 7.   Average Wood Fuel Consumption by Rural Municipality and Season

Municipality[7]	Year round use			Heating season only			Difference in means	Difference in n
	N	Mean	Std. Deviation	N	Mean	Std. Deviation		
Deçan/Dećane	33	8.78	3.32	4	7.76	1.73	1.02	29
Dragash/Dragaš	12	9.09	8.29	15	6.30	1.98	2.78	(3)
Ferizaj/Uroševac	16	9.14	3.11	35	8.69	2.20	0.45	(19)
Fushë Kosovë/ Kosovo Polje	14	5.13	2.51	31	4.85	2.41	0.27	(17)
Gjakovë/Djakovica	23	11.07	3.77	20	8.90	3.49	2.17	3
Gjilan/Gnjilane	12	6.96	2.45	24	8.14	1.81	(1.18)	(12)
Gllogoc/Glogovac	22	5.71	1.91	25	5.60	2.16	0.11	(3)
Istog/istok	27	10.04	3.72	8	6.90	2.24	3.14	19
Kaçanik/Kaćanik	27	10.25	3.45	15	8.28	2.09	1.97	12
Kamenicë/Kamenica	23	8.70	3.11	15	10.67	7.71	(1.97)	8
Klinë/Klina	16	8.93	4.03	14	6.70	2.38	2.22	2
Leposaviq/Leposavić[8]	2	10.35	4.88	42	9.22	3.82	1.13	(40)
Lipjan/Lipljan	16	8.06	3.73	29	7.21	2.88	0.86	(13)
Malishevë/Mališevo	35	8.71	4.68	9	9.51	5.66	(0.79)	26
Mitrovicë/Mitrovica	16	7.81	5.57	18	6.44	2.93	1.37	(2)
Pejë/Peć	24	10.06	4.92	13	7.01	2.68	3.06	11
Podujevë/Podujevo	50	9.37	3.95	18	8.20	3.04	1.17	32
Prishtinë/Priština	32	10.82	6.03	29	8.07	4.52	2.76	3
Prizren	54	8.68	3.31	18	7.32	5.75	1.35	36
Rahovec/Orahovac	32	9.34	3.00	16	7.20	2.14	2.13	16
Shtime/Štimlje	10	9.66	3.56	11	10.22	4.38	(0.56)	(1)
Skenderaj/Srbica	23	6.36	2.99	18	6.56	3.05	(0.19)	5
Suharekë/Suhareka	27	10.58	6.00	16	7.68	3.23	2.90	11
Viti/Vitina	14	11.04	5.57	25	9.52	3.14	1.52	(11)
Vushtrri/Vučitrn	27	5.89	3.54	28	5.47	2.85	0.42	(1)
Zubin Potok	1	10.35		30	7.31	1.97	3.04	(29)
Zveçan/Zvećan	2	6.56	0.49	42	7.49	2.60	(0.94)	(40)
Total	590	8.88	4.33	568	7.61	3.50	1.27	22

4.1.2   Urban households

The average consumption in urban areas was lower than what was found in the rural villages[9]. Some of this is expected, as households in the municipalities may have greater

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[7] The table does not include the municipalities that were merged due to small size. The information on how this was done can be found in Section 3.1

[8] These population numbers come from the OSCE municipal profiles

access to electricity, central heating and other energy sources. When considering the range of consumption by municipality and household size, the average is between 4.57 m^3 and 8.85 m^3 during the heating season. These figures are lower than those for rural households interviewed in the 2013 Rural Survey (rural consumption ranged from 4.94 m^3 to 10.07 m^3)[10].

The demand for wood fuels in urban areas was estimated at 428 015 cubic meters. Assuming that urban households outside of the surveyed municipalities in 2011 follow a similar pattern of consumption, demand was calculated using the survey average of 6.69 m^3 per household for the remaining 26 778 urban households from the Census that consume wood. This resulted in an estimated demand of 179 135 m^3 which when added to the surveyed urban areas, the estimated demand for urban households in Kosovo is 607 151 cubic meters of wood fuel annually (Table 8). However, using the average annual consumption for households in urban areas does not take into account the wide variation of household types throughout the urban areas.

Table 8.   Estimated annual consumption of wood fuels (m^3) by urban municipality and wood consuming households

Municipality	N	Mean	Min	Max	Std. Deviation	Total number of households	Total wood consuming households	Est. Consumption per municipality
Ferizaj/ Uroševac	440	8.24	2.76	24.15	3.38	7653	6881	56716
Gjakovë/ Djakovica	346	6.52	2.76	20.70	3.07	8266	6511	42459
Gjilan/ Gnjilane	391	7.22	2.76	20.70	2.92	10678	9804	70831
Mitrovicë/ Mitrovica	478	5.97	0.69	24.15	2.86	8664	7853	46908
Pejë/Peć	413	7.43	2.07	24.15	2.43	9694	8680	64504
Prishtinë/ Priština	448	4.91	0.69	15.18	2.19	33651	17550	75213
Prizren	440	8.24	2.76	24.15	3.38	16965	14543	71385
Other Urban households		6.69				30485	26778	179135
Total								607151

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[9] It is also important to note that given the difference in years, other factors like temperature may also have played a role in these averages.

[10] One difference between the 2013 Rural Survey and the 2011 Urban Survey is also the average temperatures for the heating season. The temperatures for the 2013 year were unseasonably warm, with only 59 days with lows below 0 degrees.

Table 9.   Estimated annual consumption of wood fuels (m^3) in Kosovo for rural and urban households

Categorization	Estimated Consumption Per Municipality (m^3/year)
Rural	1 447 270
Urban	607 150
Total	2 054 420

Combining the total annual wood fuel consumption estimated from the 2013 Rural and 2011 Urban Surveys yields the approximate household wood fuel consumption in Kosovo is 2.05 million cubic meters per year.

This estimate was based on the data collected on measures of the average wood fuel use and Kosovo population data extracted from the 2011 Census. This estimate takes into account the differences in location of the municipality and the rural-urban differences that affect consumption. Based on the spatial differences in wood consumption, along with the urban and rural demographics, the consumption of wood fuels was spatially oriented and then used as an input for the WISDOM model (Figure 8).

Figure 8. Map of woody biomass consumption in Kosovo households

4.2 Use of wood biomass in schools

In addition to consumption in the residential/household sector, schools are also significant consumers of wood biomass. Based on the data collected for the 1 087 schools, only 16 schools in Kosovo usecoal exclusively and 580 schools usewood fuels exclusively. Two hundred and ninety-one schools use a combination of woodfuel and coal. There are 125

schools that use heating oil, two schools that use natural gas or LPG and no data about type of fuel used was available for 75schools.
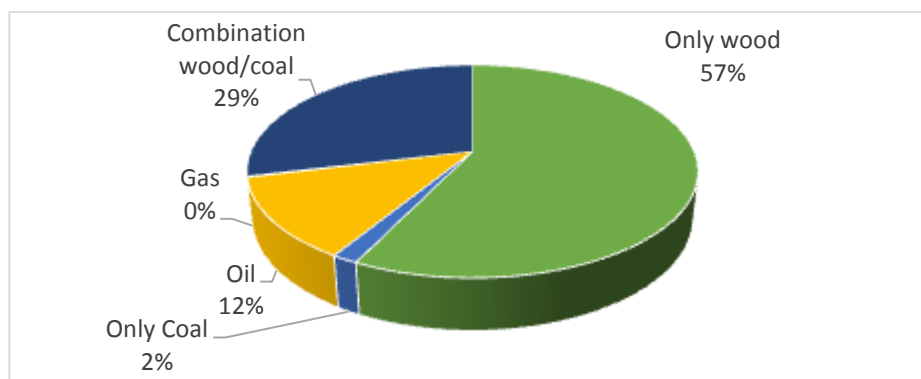

Figure 9. Share of schools using different fuels for heating

The majority of schools (57 percent) use only wood for heating (Figure 9). Total consumption of wood for all schools using wood in heating season 2012-2013 was estimated to be 33 821 m^3 of wood. Schools were typically buying only 1 m long wood[11]. Besides wood fuel consumption, schools consumed11 550 tonnes of coal, 1 742 587 litres of heating oil and 24 000 m^3 of LPG for 2013. The percentage of costs to each fuel and combination can be seen in Figure 10.
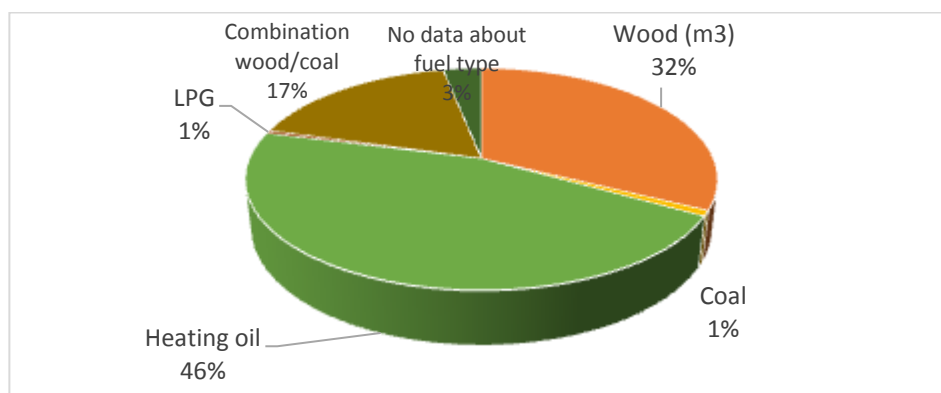
Figure 10. Structure of total costs for different fuels used in schools in Kosovo

The cost of this fuel consumption is more than EUR 4.7 million per year; of this number, 46 percent goes to the purchaseof heating oil and 32 percent towards wood fuels (EUR 1.54 million).

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[11] *Data was gathered in stock m, in order to calculate to solid wood a factor of 0.75 was used, so that all wood consumption in the WISDOM model is in solid m^3*

4.3   Use of wood biomass in tourist facilities

According to official data (data obtained from Business Registration Agency), there were 5 295 tourist facilities registered at the beginning of 2014[12]. The type of registered businesses according to their activity can be found in Figure 11. During winter 2013-2014 more than 260 tourist facilities throughout Kosovo were visited by the team of researchers and 253 questionnaires were completed. Based on the total number of registered businesses, this represents 5 percent of all tourist facilities. In order to maintain consistency with the official register,some categories were merged. For example, pizzerias were categorized as restaurants and grill houses were categorized as fast food.
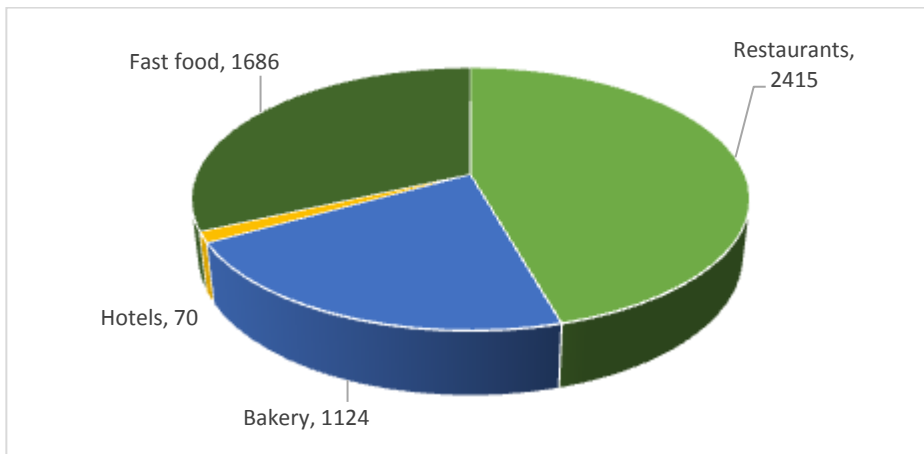

Figure 11. Number of different type of touristic objects in Kosovo (February 2014)

Based on the surveyed businesses, the total amount of wood fuel used in different types of operations is estimated at 183 321 solid m^3 annually. The majority (48 percent) of the wood fuels consumed in the sector is used in bakeries for preparation of food. Restaurants consume 42 percent of the wood fuel estimated for preparation of food and potentially for heating. Hotels consume 1 percent of the total estimated amount and they useit mainly for heating. Fast food facilities consume 8 percent of total estimated amountof wood fuels for cooking and in some cases (around 10 percent) also for heating.

Tourist facilities, like other consumers in Kosovo use a combination of fuels for heating and cooking. These tourist facilities include hotels, restaurants and pizzerias, bakeries and fast food. In addition to wood fuels, these businesses consume other fuels like heating oil, coal and gas (Figure 12). However, these other fuels were outside of the scope of the study and were not analysed in detail.

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[12] *The Kosovo Business Registration maintains records of businesses that have gone idle and have not unregistered.*
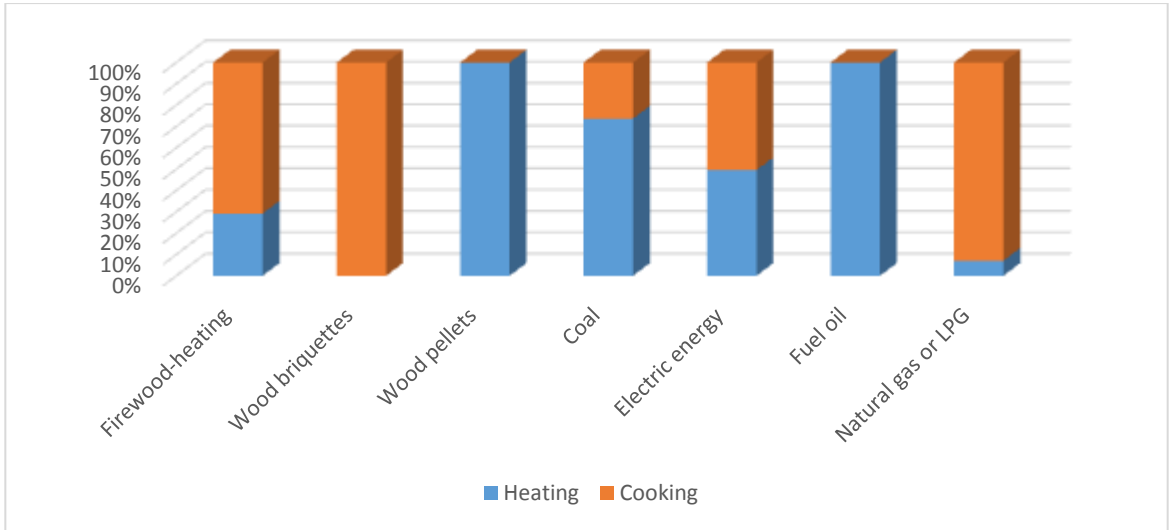
Figure 12. Use of different fuels in touristic facilities

5 INTEGRATION MODULE

5.1 Local supply/demand balance

After development of the demand and supply modules in the GIS, the next step is to integrate the information from the two modules. Integration is done through combining variables related to wood fuel consumption/demand and supply that have been systematized for each minimum administrative unit of analysis (R. Drigo, O.R. Masera, and M.A. Trossero 2002). The Integration Module balances supply and demand at cell level by subtracting current consumption from supply potential for all relevant assortment categories (Drigo, 2011). In the Kosovo WISDOM model, the supply/demand balance analysis was calculated by administrative units (municipalities) through the aggregation of cell-level balance data, which implies that at each 50m cell, supply and demand were balanced before aggregation. The current balance scenario was also considered, as summarized in Table 10.

The results indicate that for the 2014 estimates, 24 municipalities have a negative balance (Table 10). This indicates that the supply of wood fuels in these municipalities needs to be improved, indicating regions in which the policy may point to increases in replanting or decreases in harvests. The municipality with the highest deficit was Ferizaj with a negative balance of 48 046 tonnes annually. Some municipalities are doing better with 13 tonnes (35 percent) maintaining a positive balance, where the supply is greater than the demand annually. The municipality with the highest surplus was Shtërpcë/Štrpce with 111 038 tonnes annually. The spatial mapping of the deficits and surpluses can be seen in Figure 13.

Assuming fewer restrictions on harvesting, the first zone of National parks does not change the share of deficit and surplus balance in municipalities (seven changes of balance). In this case, three municipalities that are already in a negative balance (Pejë/Peć, Prizren and Suharekë/Suvareka) result in even higher deficits.

Table 10. Results for actual balance at municipality level

ID	Municipality	Total area (ha)	Current balance (tonnes)
1	Deçan/Dečane	29 374	41.835
2	Gjakovë/Djakovica	58 715	-43.419
3	Gllogoc/Glogovac	27 568	-15.407
4	Gjilan/Gnjilane	40 663	-12.282
5	Dragash/Dragaš	43 579	11.975
6	Istog/Istok	45 237	8.733
7	Kaçanik/Kaćanik	21 145	-542
8	Klinë/Klina	30 902	-21.521
9	Fushë Kosovë/Kosovo Polje	8 412	-9.306
10	Kamenicë/Kamenica	40 803	76.233
11	Mitrovicë/Mitrovica	33 617	-5.583
12	Leposaviq/Leposavić	53 511	62.401
13	Lipjan/Lipljan	33 845	-19.488
14	Novobërdë/Novobrdo	20 394	5.674
15	Obiliq/Obilić	10 484	-2.024
16	Rahovec/Orahovac	27 591	-36.043
17	Pejë/Peć	59 834	-8.373
18	Podujevë/Podujevo	64 080	231
19	Prishtinë/Priština	51 669	-38.038
20	Prizren	62 763	-20.163
21	Skenderaj/Srbica	37 434	-11.613
22	Shtime/Štimlje	13 444	-15.336
23	Shtërpcë/Štrpce	24 777	132.996
24	Suharekë/Suvareka	36 100	-3.464
25	Ferizaj/Uroševac	34 456	-52.833
26	Viti/Vitina	27 406	-23.806
27	Vushtrri/Vučitrn	34 482	-19.472
28	Zubin Potok	32 797	42.544
29	Zveçan/Zvećan	12 263	1.631
30	Malishevë/Mališevo	30 648	-28.696
31	Hani i Elezit/Elez Han	8 331	4.343
32	Mamushë/Mamuša	1 095	-2.297
33	Junik	7 776	10.239
34	Kllokot/Klokot	2 339	-3.404
35	Graçanicë/Gračanica	13 132	-6.567
36	Ranillukë/Ranilug	8 851	3.936
37	Partesh/Parteš	2 866	-3.091
	Total	**1 092 379**	**+/-0**

Figure 13. Map of wood biomass supply and demand balance for Kosovo (2013)

6   WOODSHED ANALYSIS

6.1   Accessibility of biomass resources

One aspect to changing the balance of supply and demand of wood fuels has to do with how accessible the resources are in terms of cost to harvest and collect the wood fuels. Based on the DEM (Digital Elevation Model), the map of accessibility is calculated by the cost-distance from the nearest accessible roadway. The "origin" layer was created by merging of all major roads in Kosovo and the "cost" layer[13] was calculated bythe slope, as the slope increases the costs of accessing and harvesting the wood increases. The continuous values of the resulting cost-distance map were then segmented into discrete classes. This raster represents the level of accessibility in relation to their location. The Figure 14 shows a fragment from map of 20 accessibility classes derived from the cost-distance map. Class 1 is the most accessible area close to roads while class 20 is the least accessible class in the most remote areas (cell with value 15 or higher can be assumed as closed for forest exploitation.
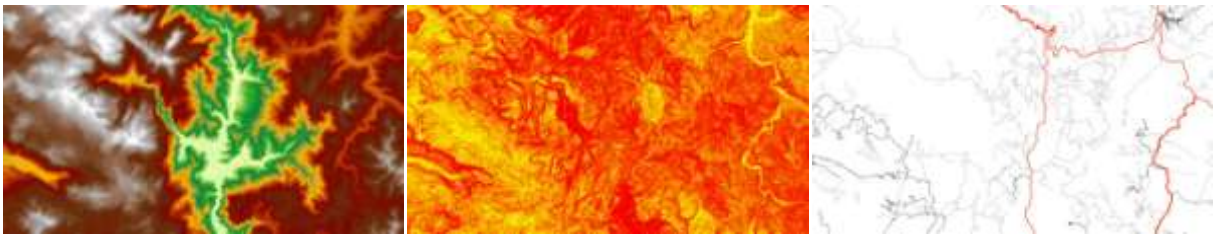

Figure 14.Maps of the terrain heights, slopes and road layer (all roads)

The available GIS layer of roads is appropriate for general purpose, but for detailed planning in the future it should be revised based on quality of the road and alternative pathways. For more detailed planning, it will be necessary to supplement the layer with the lines of low class roads, especially forest roads or even skidding trails in the forest to be more cost reflective of the situation on the ground. The maps for Kosovo are color-coded, with forest areas in red having little to no access to delineated forests roads. The cost-distance map for all of Kosovo can be seen in Figure 16.
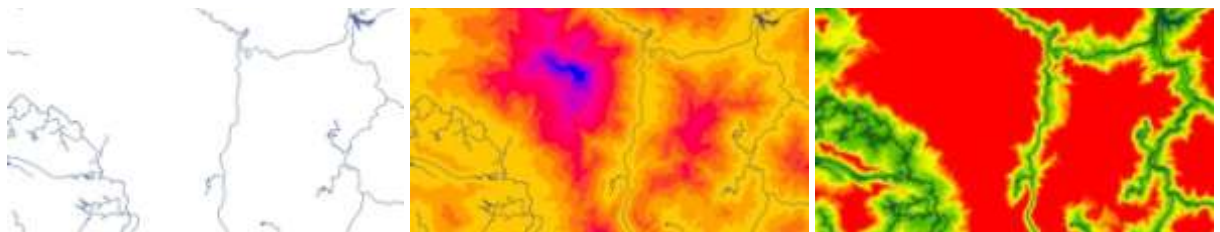

Figure 15.An example of cost distance procedure (1 – selected roads, 2 - cost distance map, 3 - cost distance map, reclassified)

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[13] *All raster layers have 50×50 meter pixel (2.500 m2).*
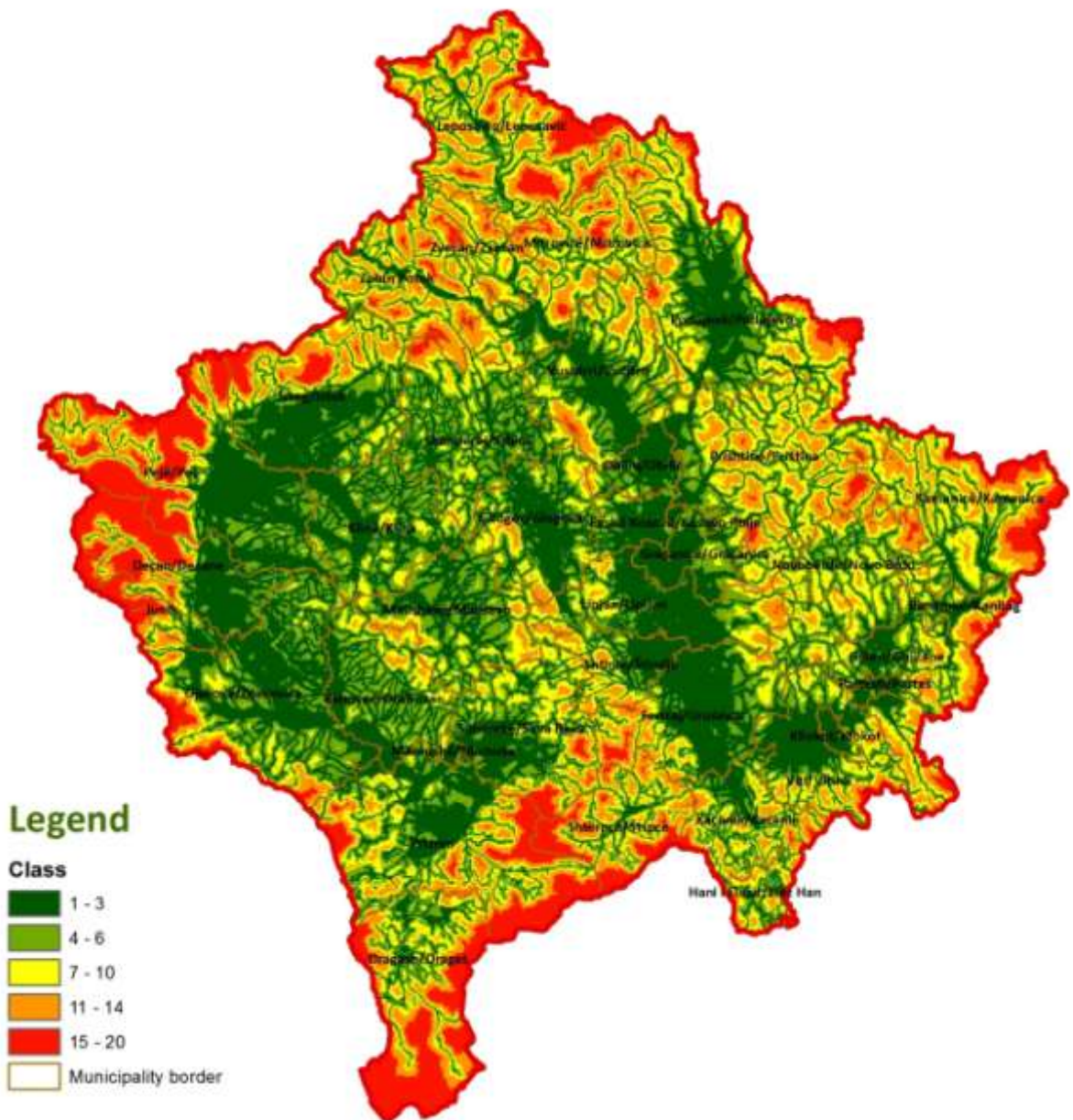
Figure 16. Cost distance map of Kosovo

6.2   Analysis of suitable locations for woody biomass plants

One ongoing debate in the energy sector is about potentially using the forest as a source for alternative biomass energy generation, which includes biofuels, co-fired electricity plants and pelletization for household use. The Kosovo WISDOM model and the supply/demand balance data can be used to define suitable locations for these biomass

plants. Without defining the exact locations for these hypothetical plants, the analysis is done for the entire country, the scope of which is to determine the supply potential of each map pixel assuming different supply radii (Drigo 2011). For analysis ArcGIS Spatial analyst extension tool was used (function FocalStatistics (neighbourhood group)). This function adds the supply availability within a specified neighbourhood (10 km, 20 km and 30 km in our case) for each cell location on an input raster and sends the sum to the corresponding cell location on the output raster. These locations indicate the impact on the supply balance if the biomass plants were to locate and source their material within the designated radius. Plants that have larger supply regions may be able to spread their impact over a larger surface area, though any increase in distance would decrease the profitability in terms of higher transportation costs. Other factors that may be worth exploring in the future would be the potential outcomes of increased forest harvests on other economic or environmental factors, such as soil erosion and biodiversity impacts.
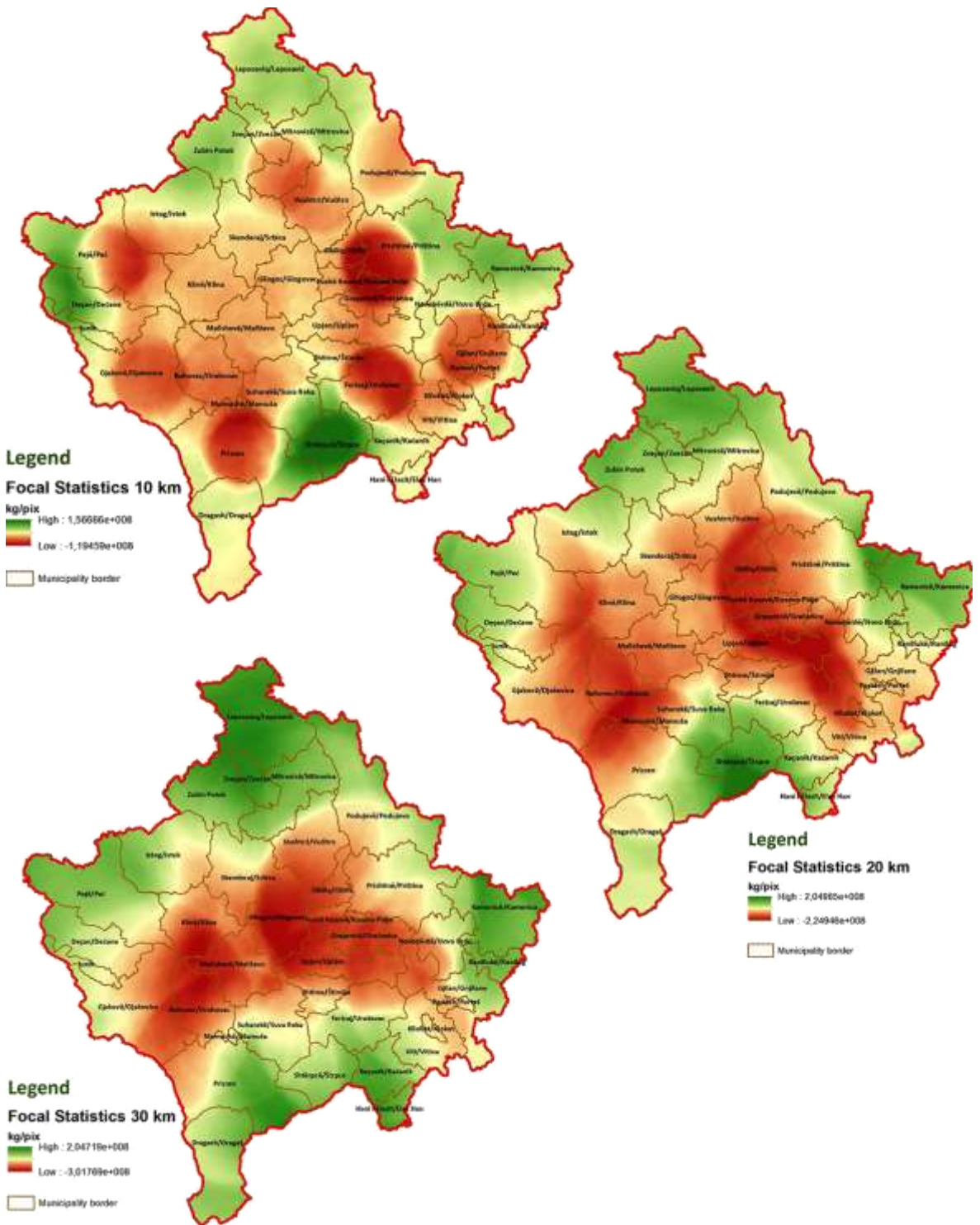
Figure 17. Analysis of suitable locations for woody biomass plants
(current consumption: 10, 20 and 30 km supply radius)

7   CONCLUSIONS AND RECOMMENDATIONS

Total wood fuel consumption is dependent on winter temperatures, socio-economic and geographic factors. Factors driving consumption alter by the rural-urban split. The average consumption varies by municipality for urban areas at between 4.91 m^3 and 8.24 m^3 and for rural areas at between, 4.94 m^3 and 10.07 m^3 of wood fuel consumed during the heating season. Thus, wood fuel demand is higher in rural areas than in urban areas by several cubic meters. Additionally, the demand for wood fuels for heating purposes is partly dependent on the temperatures of the country during the heating season.

Economic pressure and availability issues can drive the substitution of wood for electricity. In remote rural areas the security of energy for heating is especially important. One possible driver of wood fuel use in these areas is the unpredictability of Kosovo's electric energy supplies in colder months. Therefore, one strategy for reducing the level of unsustainable wood harvesting may be increasing the availability and predictability of the electric supply in rural areas of Kosovo. However, in Kosovo the current trend of persons moving from rural areas to more urban locations may help mitigate unsustainable wood fuel use as many households move to more urban locations that use electric heating.

The economic situation has a significant role in home energy use decisions. This study found that households that have fewer employed members consume greater quantities of wood fuel on average. As unemployment seems to be positively correlated with wood use, any increase in unemployment might also lead to an increase in the use of wood. A decrease in real incomes may drive further the use of wood fuel, where it becomes the cheapest alternative. Therefore, public policies that reduce unemployment might help to reduce wood fuel use.

To further understand the substitution among energy resources in households, additional future work will need to be done. For example, consumption patterns through space and demand elasticities among energy resources in Kosovo need to be explored. Demand elasticities would consider a household's ability or willingness to change to an alternative source of energy given a change in prices or quantities of wood fuel available and the prices and quantities of other energy sources available. If the population in Kosovo tends to choose wood fuels over other alternatives irrespective of prices or availability, then moving away from wood consumption may be more challenging. Further research should also consider the affordability and access to other sources of energy. In particular, we need to study the households that do not participate in Kosovo's formal energy markets. This will aid policy makers in better understanding how changes in electricity prices will alter

the consumption of wood fuels and other sources of household energy and improve planning for forest sustainability in Kosovo.

There is little evidence that the wood fuel that is being cut has been left to dry. This reduces the total energy yield as the wood is being burned (unseasoned wood burns longer but cooler giving off less heat while dry seasoned wood burns more efficiently). The 2013 Rural Survey found that most wood was being used within a couple of months of cutting. As wood resources move from suppliers to consumers, the wood could be processed to improve the energy and heat yields and therefore to a more efficient use of energy resources. Changing current harvest and consumption patterns might require government intervention in the wood fuel market to provide incentives for better seasoning or pelletization of the wood prior to consumption.

The study about wood fuel consumption partially in public and partially incommercial sectors gives a good insight intothe amount of wood that is used in these sectors. According to our literature review, it is the only study of this kind that has been done in Kosovo in the last 20 years. The main results are:

- According to the data, for nearly 94 percent of all education facilities in Kosovo, gathered from local communities, around 34 000 m^3 of wood is used for heating. Besides wood coal, gas and heating oil are also used in different schools.
- According to the data gathered by special questionnaires (sample size was 5 percent of all registered facilities), the total amount of wood fuel used in different types of tourist facilities is estimated to be more than 180 000 m^3. The majority is used in bakeries for preparation of food (48 percent). Restaurants (42 percent of total amount of wood) are using wood for preparation of food and/or heating, hotels are using only 1 percent of estimated amount and mainly for heating. In fast food facilities, wood fuels (8 percent of total estimated amount) are used for cooking and in some cases also for heating.
- The wood processing industry is an important source of wood waste that can be used for energy purposes. The analysis of wood processing industries is incomplete but an overview of the sector is presented. It is estimated that around 50 000 m^3 is processed annually, but there is a question surrounding illegal cutting and processing of illegal logged wood.

For the public and commercial sectors, the wood fuel market is organized locally, where mainly 1 m long logs are sold by stock m^3. Wood is sold and also used fresh (cut and sold in less than three months) with water content more than 30 percent. In the future more emphasis should be puton education wood fuel users about quality of wood fuels,

especially wood logs. Some studies should be conducted in the field to measure water content.

It is clear that the consumption of fuel wood in Kosovo is very high and it already presents a threat to the sustainability of forests. Using dry wood in more efficient boilers and stoves would be one way to decrease demand. Substantial efforts should be focused on changing the behavior of end users – it is the tradition that should be changed and this is not an easy task.

The results of this study increase the ability of decision makers to target areas of high consumption of wood fuels throughout Kosovo. Also, aspects of the surface area of households, age, elevation and insulation that were surveyed can be used to better focus energy efficiency efforts and public awareness. The study data can be used in conjunction with other data resources on Kosovo to model the energy situation in the country. However, more information on household spending on energy resources and incomes is needed to develop strategies that could lead to a more sustainable use of forest resources.

7.1   Future improvements on the model

This work offers a decision-making tool for forest planners, forest suppliers and policy makers. This work is a preliminary effort to better manage and access forest resources and to understand the key economic and environmental tradeoffs in consuming forest resources. Future efforts will need to further hone some of the model characteristics and on the ground statistics, including the following:

- More closely monitor felling/harvests and balance it with net production, especially in private forests in order to better gauge the sustainability of the supply.
- The available GIS layer of roads is appropriate for general planning; however, it will be necessary to supplement the layer with the lines of low class roads, especially forest roads or even skidding trails in the forest to be as close as possible to reflect actual costs.
- Map of existing legal and illegal sawmills with supply and demand radius should be imported as a GIS layer.
- Land use map should be updated. At the national level it would be useful to have a better spatial definition of the agricultural land uses (fields, orchards, smaller vineyards).
- It should be determined who is formal administrator of the entire WISDOM system, and which will be responsible or maintenance and renovation of the datasets and reporting. An administrator should have a good knowledge of the content and have sufficient knowledge to be able to identify any deficiencies and will to update them competently. GIS skill sand tools are evolving very rapidly. To keep up with all new

features, usually requires some time, so it is appropriate that this process would be supplemented by an exchange of views in the wider group of professionals.

- The data collected and analysisis not an end to the debate on forest usage. Firstly, the results should be presented to all interested people, groups, municipalities and entrepreneurs that would like to plan or manage the forest resources. Connecting these stakeholders and encouraging them to make this a common geo database, which will be supplemented with information by all participants, will improve outcomes in the modelling and policy debates.

The data used in the model is suitable for producing regional action plans. However for producing local action plans, the data is too general. The WISDOM module was designed to help in decision making and placement of consumer biomass plants at the national level, although with more detailed data it can also provide a basis for decision-making at regional and local levels.

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