Woodfuels Integrated Supply/Demand Overview Mapping

WISDOM

Slovenia

Spatial woodfuel production and consumption analysis

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WISDOM – Slovenia

Spatial woodfuel production and consumption analysis
applying the
Woodfuel Integrated Supply / Demand Overview Mapping (WISDOM)
methodology

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Based on:
the work carried out in the framework of the FAO/Government of Slovenia Project “Supply and Utilization of Bioenergy to Promote Sustainable Forest Management” TCP/SVN/2901, and follow-up actions undertaken by the Slovenia Forest Service and Slovenia Forestry Institute

January 2006

Foreword

Given the importance of woodfuels in providing energy for both traditional and modern industries, as well as their relevance in forestry, energy and rural development contexts, woody biomass is an important resource that, when sustainably managed, can have positive impacts on the environment, forests, social and economic development.

To promote this process, the Forestry Department of FAO is broadening and disseminating knowledge and information on wood energy aspects and actively collaborating with member countries in the development and implementation of tools supporting wood energy planning and policy formulation.

One such tool is the Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM), a spatially-explicit method for assessing woodfuel sustainability and supporting wood energy planning through the integration and analysis of existing consumption and production-related information.

Within the framework of the Project "Supply and Utilization of Bioenergy to Promote Sustainable Forest Management", TCP/SVN/2901, implemented by the Government of Slovenia and supported by FAO, the WISDOM methodology was applied in order to acquire the knowledge base necessary to formulate national wood energy strategies that would also correspond with the criteria for Slovenia's entry into the European Union.

As on previous occasions, with the integration of spatial and statistical information from various sectors, the WISDOM approach proved to be an efficient way to boost understanding of wood energy and to provide useful elements for the formulation of new strategies.

Prior to project implementation, a holistic approach to the wood energy sector was lacking. Existing information was fragmented and failed to provide a coherent appreciation of the sector's relevance in the context of both forestry and energy. The WISDOM approach allowed for the reconciliation and consolidation of forestry data with data from other sectors, and, with limited additional data collection, produced a coherent vision of the status and potential of wood energy in Slovenia, summarized in the Slovenia Wood Energy Information System (SWEIS). This study brought new awareness of the opportunities offered by wood energy and sharply enhanced the capacities of the Forest Service to cope with the challenges of planning and providing information to stakeholders, as well as the public at large

The value of the WISDOM and SWEIS analyses was evident in the actions undertaken by the Slovenia Forest Service and Slovenia Forestry Institute shortly after project completion. These follow-up actions included the development of a tailored WISDOM analysis for five municipalities interested in developing pellet production and district heating systems; the formulation of a national wood energy strategy within the National Forestry Programme and the National Programme for Rural Development; and the preparation of the Slovenian Wood Biomass internet portal that provides state-of-the-art information on all aspects of wood energy in Slovenia.

Another important outcome of the Project is that the Slovenian Government is now playing a catalytic role in promoting similar activities in other countries of East and Central Europe, alongside regionally coordinated activities proposed by the Forestry Department of FAO. To boost the process, the Slovenian Ministry of Agriculture, Forestry and Food, in collaboration with FAO, hosted an international workshop, "Development of Woody Biomass for Energy in Central and Eastern European Countries", which was held in Bled, Slovenia, in November 2005, with the participation of delegates from twelve countries of the sub-region.

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Acknowledgements

Given the cross-sectoral and multi-disciplinary character of wood energy, the development of the WISDOM geodatabase could not be possible without the competent contributions of many persons from different Slovenian institutions.

The authors highly appreciate the availability and friendly collaboration that responded to their numerous and, at times, pressing requests for data and maps. In particular, the authors wish to express their gratitude to:

Miguel Angel Trossero, FAO Wood Energy Programme, for his wise supervision;

Andrej Grum, Slovenia Forest Service (SFS), for his efficient Project coordination;

Andrej Kermavnar, SFS Director, Jurij Begus, Robert Ogrizek, Rok Pisek and Dragan Matijasic, SFS, for their friendly availability and advise;

Nike Krajnc, Slovenia Forestry Institute (SFI), for her dedication and generous competent contribution;

Mirko Medved and Milan Hocevar, SFI, for their contributions and the many interesting discussions;

Peter Prosenc, for his precious assistance in the survey of non-forest biomass

Summary

Slovenia is a nation rich in forests that cover almost 60% of its land area. The country also has considerable amounts of trees and shrubs on other, non-forest categories of land, especially on abandoned farm lands. Therefore, there is tremendous potential to develop woody biomass as a renewable source of energy. Current forest cutting does not reach half the estimated annual increment leaving this energy resource largely unexploited.

In order to acquire the knowledge base and planning tools necessary for the formulation of a sound bioenergy strategy the Government of Slovenia, supported by FAO, executed the Project "Supply and Utilization of Bioenergy to Promote Sustainable Forest Management", TCP/SVN/2901, implemented between July 2003 and June 2004. This Working Paper summarizes the results and the main methodological features of the Information Component of the project.

The objective of the Information Component was to assist the Slovenian Forest Service (SFS) in strengthening wood energy planning and policy formulation and in developing an adequate spatial and statistical information base. More specifically, the objectives were to develop a series of thematic wood energy maps, following the methodological approach named Woodfuels Integrated Supply/Demand Overview Mapping (WISDOM)[1] and to contribute to the creation of the Slovenia Wood Energy Information System (SWEIS), providing a comprehensive vision of current woodfuel flows and of the potential for bioenergy development.

The activities carried out included the review, harmonization and integration, at the lowest possible administrative level, of all available information related to supply and demand of woodfuels, the spatial representation of supply sources and current fuelwood[2] consumption levels, especially for the household sector where consistent data was lacking. One specific activity concerned the design and implementation of the survey of biomass stocking and productivity of non-forest land uses, such as farmlands, orchards and pastures that are important fuelwood supply sources for which no information existed.

The main output is the Slovenia WISDOM, which includes a geodatabase at the level of Cadastral Community (KO) providing details on current and potential woodfuel production and consumption patterns (and related parameters) and the first versions of the Slovenia Wood Energy Information System (SWEIS), which provides a national-level overview.

WISDOM – Woodfuels Integrated Supply / Demand Overview Mapping

WISDOM is a spatially-explicit method designed to support strategic wood energy planning and policy formulation, through the integration and analysis of existing woodfuel demand and supply related information and indicators.

The Slovenia WISDOM analysis was based on 2696 Cadastral Communities (KO, from Katastrske Občine), which represent the Slovenian territorial structure and a serve as reference for both forestry and demographic statistics. A cartographic layer was added to illustrate the distribution of some 6000 human settlements providing basic demographic data.

The integration and elaboration, at KO level, of data from existing statistics (forestry, census, land use, etc.) and from the new survey on woody biomass outside forests, resulted in a rich data set of over 100 parameters related to woodfuel consumption and supply. In addition, point data allowed the distribution of wood industries, biomass plants, district heating systems and associated parameters.

WISDOM provided a holistic vision of the wood energy sector at the national level and an aggregation of key parameters constituted the main entry of SWEIS. As a planning tool, the main value of WISDOM is in its spatial character. Its fine spatial and thematic resolution makes it a flexible tool for the representation of Slovenia's fuelwood production/consumption situation in different locations and for the definition of priority areas from a variety of perspectives.

[1] Methodology developed by FAO Wood Energy Programme in collaboration with the National Autonomous University of Mexico [7].

[2] Fuelwood is by far the most important type of woodfuel in Slovenia, since charcoal is rather negligible and black liquor is produced and consumed directly by the single paper mill of the country. Therefore, in this paper the term "fuelwood" will be used, rather than "woodfuel", unless otherwise specified.

SWEIS - Slovenia Wood Energy Information System

SWEIS summarizes at national level the production, import, export and consumption of woodfuels over the period 1995 - 2002. SWEIS uses the national-level totals of selected parameters that were developed for WISDOM Slovenia as well as additional data from the Statistical Office of Slovenia and other sources. It includes all data important for planning and designing wood energy policies, and, in the organizational sense, it provides for regular gathering of these data.

Main findings and conclusions

The main Project contributions are: i) the new estimates of woodfuel consumption where the household sector absorbs the largest share, and ii) the first estimation ever done of woody biomass stocking and productivity by land use class in non-forest lands in Slovenia.

Key findings resulting from the elaboration of WISDOM and SWEIS are the following:

- Approximately 1.9 million m^3 (mm^3) of wood was used as an energy source in Slovenia in 2002, of which 1.3 mm^3 was consumed by the household sector and 0.6 mm^3 by the industrial sector, including biomass energy systems. It appears that there are two fairly independent woodfuel circuits: one household circuit that uses fuelwood mainly from forests and farmlands (and marginally charcoal) and one industrial circuit that uses residues mainly from the wood, pulp and paper industries.
- The comparison of these consumption estimates with existing fuelwood production data from SFS Statistics lead to the conclusion that “Fuelwood” reported by the Statistical Office of Slovenia represented only a small fraction (some 20%) of the volumes actually used as fuel. The “official” fuelwood production highlighted the fact that the energy use was not adequately recognized and studied in the national context. This situation had prevented adequate analysis of role of forests in the energy sector as well as the analysis of the share of wood fuels in the national energy mix.

<u>Supply issues</u>

- The Project results suggest that the potential supply of woodfuels could be more than double today’s extracted volumes without limiting the timber industry or affecting the growing stock, considering that:
  - the volume actually extracted from the forest in recent years was only part of the allowable cut (some 60-70%)[3];
  - the allowable cut itself (currently 4 million m3/yr) is less than 60% of the estimated annual increment, which has been steadily increasing from 5.3 million m^3 in 1990 to 7.3 million m^3 in 2003);
  - the forest stocking increased from 207 million m^3 in 1990 to 286 million m^3 in 2003; and
  - over the period 1975-2000, the forest area has been increasing at an annual rate of 0.4% (almost 5000 ha every year) due to abandoned farmland.
- Given the above, a more intense fuelwood production (through thinning, for instance) is not only possible, it is highly recommended since it would be beneficial to forest health conditions, on stands resistance to extreme weather conditions and for the quality of the country’s industrial timber.
- Although it is known that a significant share of fuelwood for household use is collected by farmers in their own non-forest lands, no information had existed before this study on the wood stock and productivity of these areas. The survey of non-forest woody biomass, conducted in the

[3] Of the 4 million m3 of the annual allowable cut, only 2.4 were actually extracted on average during the period 1991-2001. Although in recent years the cut fraction has increased to some 2.8 million m3, the biomass built-up represents a serious threat to the health of Slovenia forests.

framework of the project, produced the first objective estimation of wood stocking and annual increment outside forest areas in Slovenia. The standing volume in non-forest areas (including meadows, abandoned agriculture, agro-forestry, urban areas, orchards, etc.) amounted to some 11.5 million m^3, with an estimated annual increment of some 400 000 m^3. From this resource, approximately 300 000 m^3 are probably used as fuel every year[4].

- Data on wood residues from forest industries was limited and not up-to-date. However, based on best available information, the annual production of wood residues at year 2002 was tentatively estimated at some 553 000 m^3.

Demand issues

- In Slovenia there are two fairly independent woodfuel consumption-production circuits:
  - a "household" circuit that uses mainly fuelwood (and marginally charcoal) from forests and farmlands, and
  - an "industrial" circuit that uses mainly residues from wood industries and paper mills.
- At present, almost all fuelwood consumption in Slovenia is absorbed by the household sector for heating. Fuelwood meets about one third of national energy demand for household heating. In spite of its relevance, reliable statistics on fuelwood consumption did not previously exist. New estimates were produced using 2002 Census data and previous studies on average energy requirements. According to these estimates, almost 1.3 million m^3 of wood were used in 2002 by Slovenian households.
- The information available on industrial wood energy consumption was fragmented and recent data largely incomplete. Based on available references, the consumption of industrial biomass systems was estimated to be approximately 500, 000 m^3 in 2002.

Integration

- Several supply/demand balance scenarios, focusing mainly on the "household" sector, were created and mapped at KO level, considering the current and potential production levels from forests and non-forest areas. These maps, along with other socioeconomic aspects, will be essential in identifying the locations for new wood energy plants, such as those planned by the Slovenian Energy Agency.
- As an example of priority zoning, three identified components that are of particular relevance in future forestry planning of woodfuel production were combined, these are: (i) high surplus of non-timber assortments suitable for energy use; (ii) high fragmentation of forest properties; and (iii) high proportion of forest stands at thinning stage. These areas are critical under the forest management viewpoint. In these areas forest owner associations should be promoted in order to achieve an acceptable profit level for the owners to undertake the needed sylvicultural treatments that are otherwise neglected. In these contexts, energy offers good profit opportunities that benefit both the society and the forest ecosystem.

Impact of WISDOM on policy development

The timeliness of WISDOM analysis was evidenced by the good reception by the Forest Service and by the immediate use made of the geodatabase as well as of the SWEIS overview. In fact, within a few months of the Project's conclusion, the WISDOM Slovenia geodatabase was used for: (i) support and as a basis for local wood energy planning in five municipalities through the development of a tailored WISDOM analysis and (ii) for the definition of a draft national strategy and the inclusion of wood energy components in the National Forestry Programme and in the National Programme for Rural Development, both under preparation.

[4] These values represent the first estimation ever done of non-forest woody biomass. However, since the variance of tree cover outside the forest is extremely high, the margin of error is very wide and they should be considered indicative only.

The WISDOM data set, aggregated at the municipal level, is currently being used as a key ingredient in the preparation of the Slovenian Wood Biomass internet portal that will provide easy access to state-of-the-art information on all aspects of wood energy in Slovenia. A special sector will be dedicated to the ranking of local communities according to suitability for wood energy development under different management perspectives.

As a result of the Project, Slovenia has played catalytic role in promoting similar activities among the countries of East and Central Europe. Such role was performed in the context of a regionally coordinated action promoted by the Forestry Department of FAO, in the two occasions below, where the features of WISDOM and SWEIS were presented and discussed:

- the first working meeting on "Supporting Wood Energy Planning in Eastern Europe", at FAO headquarters in Rome on 16 March 2005, as a side event of the 2005 FAO Committee on Forestry (COFO), attended by representatives of 13 Central and East European countries and 3 international organizations;
- the international workshop, under the title "Development of Woody Biomass for Energy in Central and Eastern European Countries", hosted by the Slovenia Ministry of Agriculture, Forestry and Food in collaboration with FAO, organized by the Slovenia Forest Service and held from 9 to 11 November 2005 in Bled, Slovenia. Delegates from 12 countries participated to the three-day meeting: Estonia, Czech Republic, Romania, Bulgaria, Macedonia, Serbia, Croatia, Hungary, Sweden, Italy, Latvia and Slovenia.

Follow-up

In order to maintain long-term effectiveness of WISDOM and SWEIS as planning tools, it is recommended that Slovenia continue the process of data collection and further develop it. Future data collection should include the following information:

- fuelwood consumption time series data for the household sector, or related indicators; this information will allow for the assessment of consumption trends and the elaboration of possible short-term development scenarios;
- complete data on the production of wood residues by forest industries and on woodfuel consumption and energy production by biomass plants.
- accessibility factors that limit the full exploitation of the country's wood energy potential from a physical, legal and economic perspective.

As mentioned above, the official national statistics on woodfuels are incomplete and do not reflect the true role that wood energy plays in both forestry and energy sectors. This is a major limitation in the development of this sector. It is therefore strongly recommended that the Statistical Office of Slovenia define, in collaboration with forestry and energy authorities, a set of wood energy variables and that specific attention be given to the production and consumption of individual woodfuels in future statistical surveys of both forestry and energy sectors.

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Acronyms

CHP	Combined heat and power plant
CUM	Cubic meter (m^3)
CV	Coefficient of variation
DHS	District Heating System
dw	Dwelling
inh	Inhabitant
KO	Katastrske Občine (Cadastral community)
MJ	Megajoules (10^6 joules)
PJ	Petajoules (10^{15} joules)
SFI	Slovenia Forestry Institute
SFS	Slovenia Forestry Service
SWEIS	Slovenia Wood Energy Information System
SWEM	Slovenia Wood Energy Map
TCP	Technical Cooperation Programme of FAO
WISDOM	Woodfuels Integrated Supply/Demand Overview Mapping

1. Introduction

1.1 Background

Slovenia is a nation rich in forests that cover almost 60% of its land area. The country also has considerable amounts of trees and shrubs on other, non-forest categories of land, especially on abandoned farm lands that are overgrown with forest vegetation. Therefore, there is tremendous potential to develop woody biomass as a renewable source of energy. Current forest cutting does not reach half the estimated annual increment leaving this energy resource largely unexploited.

In the last decade, Slovenia has introduced market reforms by harmonizing legislation with the European Union and opening markets through large structural changes among which was a denationalization process that returned nationalized properties, including many forests, to private citizens-- bringing about changes in their ownership structure. This modified, in various ways, the relation between man and forest in the country.

The share of the farming population has dropped considerably, which implies that the share of farmers among forest owners has decreased. A direct consequence is that forest owners have limited access to the forests and to the equipment needed for forestry operations. In particular, the incentives to extract wood biomass from forests decreased considerably.

Forest owners are increasingly dependent on forest enterprises when it comes to forest management. However, these enterprises are interested in logging marketable timber; therefore thinning in younger forests is not carried out to the required extent. This decreases the stability and the quality of younger forests. Moreover, biomass that could be used for heating is left in the forests and, due to the lack of thinning, wood products from these forests are also less competitive.

As result, while the cutting in the forest under direct state control remained in line with the allowable cut, in private forests the cutting rate dropped considerably. Statistics for the period 1991 – 2000 indicate that only 54% of the allowable cut was actually extracted. Considering that two years' cut was already done before the denationalization process, it is highly probable that actual cutting in private forests has not reached even half of the allowable cut. Furthermore, it is important to note that the allowable cut itself was very conservative, as it covered only some 60% of the current mean annual increment.

The Slovenian Forestry Service (SFS) and Forestry Institute (SFI) have concluded that the utilization of woody biomass as fuel to be used internally and/or exported could be a good option for the diversification of forestry activities. In fact, biomass development could foster the increased productivity of forests providing new sources of income for people living in and around these areas and thus become an environmentally sound and locally available source of energy [5] [6] [10]. However, there was little and fragmented information of the role of wood energy and its development potential that was limiting effective planning and policy for the development of the sector.

In order to find viable solutions to this impasse and to promote a sustainable development of the wood energy sector, the Government of Slovenia, supported by FAO, implemented the Project "Supply and Utilization of Bioenergy to Promote Sustainable Forest Management" TCP/SVN/2901. The Project was implemented over the period 2003-2005. The Wood Energy Programme of FAO Forest Products and Economic Division (FOPP) was the Lead Technical Unit involved in the provision of technical assistance and supervision.

The content of the Project was wide and it captured all areas important for the promotion of utilization of wood biomass in Slovenia for energy purposes. The entire project included the following elements:

- Wood energy maps,
- Wood energy information system,
- Socioeconomic aspects of wood energy,
- Analysis of woodfuel market,
- Extension on the field of wood energy, and
- Dissemination of knowledge, strengthening of public awareness.

The present report covers the Information Component of the Project, which included the first two elements, i.e. "Slovenia Wood Energy Maps" and "Slovenia Wood Energy Information System".

In developing the Information Component of the project the challenge inherent to wood energy planning was evident. The challenge came in two parts. First, the inter-sectoral character of wood energy, which encompasses energy, forestry, agriculture and rural development issues needed to be addressed. And second, the fact that the patterns of woodfuel production and demand, and its associated social, economic and environmental impacts, are site specific. It was clear that adequately assessing the implications of current woodfuel production and use and the sustainable potentials of woodfuel resources required a holistic view and a better knowledge of the spatial patterns of woodfuel supply and demand.

In fact, experience shows that broad generalizations about the woodfuel situation and impacts have often resulted in misleading conclusions, poor policies and failed to attract the required institutional recognition and resources.

In order to respond to the need for spatial and intersectoral data the activities followed the methodological approach named **Woodfuels Integrated Supply / Demand Overview Mapping (WISDOM)**, which was developed by FAO Wood Energy Programme in collaboration with the National Autonomous University of Mexico [7]. At the time of writing, the WISDOM methodology was implemented in Mexico and Senegal and, with a sub-continental approach, to over ten Central-Eastern African Countries[5] and South-East Asia.[6]

The WISDOM methodology constituted the basis for the development of both elements of the Information Component. The analysis conducted may be considered the Slovenian application of this methodology and therefore this entire report is titled Slovenia WISDOM.

1.2 Objectives

The scope and objective of the Information Component was to assist the Slovenian Forest Service (SFS) in strengthening wood energy planning and policy formulation and in developing an adequate spatial and statistical information base. More specifically, the objectives were to contribute to the creation of the Slovenia Wood Energy Information System (SWEIS) and to develop a series of thematic wood energy maps, following the WISDOM methodology.

In other words, the objectives required an understanding of the true potential of wood energy as an economically and environmentally sound alternative or complement to fossil fuels. Key questions to be answered concerned the quantities and locations of the present production and consumption of wood biomass in Slovenia; the sustainable production potentials; and the locations where it is suitable to develop utilization of wood biomass for energy purposes.

The immediate objectives of the **Information Component** were the following:

- to integrate the rich but fragmented information relevant for wood energy planning in Slovenia into a spatially explicit dataset;
- to fill critical information gaps concerning:
    - woodfuel consumption by user groups;
    - location, stocking and current/potential productivity of woody biomass supply sources including forests and non-forest lands;
- to identify the zones most, or least, suitable for the development and implementation of wood energy projects;
- to prepare the Slovenian Wood Energy Information System (SWEIS) providing statistical data on fuelwood, charcoal and black liquor production, consumption and trade (import, export);
- to suggest the most suitable institutional arrangements for long-term implementation of SWEIS within SFS and the liaison with other partners involved in supplying and using the data collected.

[5] Drigo, R. East Africa WISDOM - Wood energy mapping of selected African countries. FAO Wood Energy Programme. In press

[6] Drigo, R. SE Asia WISDOM - Wood energy and poverty in Continental SE Asia. FAO Wood Energy Programme and Poverty Mapping Project. In press

2 Results and findings

Before the project, several studies were conducted on various aspects of wood energy in Slovenia [5] [6] [10] but the information remained largely fragmented and incomplete. A comprehensive vision of the wood energy sector was missing and, most relevant, there was no clear perception of the importance of woodfuels among forest products and of the share of wood fuels in the national energy mix.

Particularly weak was the information on the level of fuelwood consumption in the household sector, which is by far the main user of wood energy, on the role played by non-forest land uses as sources of fuelwood in rural areas and on the production/consumption of industrial wood residues. The investigation carried out in the framework of the project, and particularly through the development of WISDOM, allowed for the filling major information gaps-- for years of reference data (2000 – 2002) and to build a first complete vision of this sector and its potential.

The main results and findings of the Information Component of the project are presented following the two main steps that led to the construction of a comprehensive national information resource:

- The development of the Slovenia WISDOM geodatabase
- The Slovenia Wood Energy Information System (SWEIS)

In this section only the results and findings that were considered most relevant for a comprehensive view of the wood energy sector are presented. They are the final outcome and synthesis of the combination of several thematic layers each of which represent an important result of the study. The intermediate results include, for instance, estimation and mapping of fuelwood consumption; mapping of current and potential forest biomass production, woody biomass resources and productivity of farmlands, pastures and other non-forest lands; and others. These thematic layers and relevant results are presented in the following sections that describe the development of WISDOM and SWEIS.

2.1 Slovenia WISDOM

The Slovenia WISDOM allowed a first holistic and coherent vision of the main aspects of fuelwood demand and supply and their spatial relation. It provided, for each of the 2696 Cadastral Communities (KO) that compose the Country, all variables relevant to the wood energy sector that could be assembled from a variety of sources and/or estimated through analytical processes and surveys.

The spatial and statistical data was structured in form of geodatabase, named KOWISDOM, which combined the spatial and statistical elements and allowed a convenient handling and presentation in both Microsoft Access (database features) and ESRI ArcMap environments.

Annex 4 describes the attributes of the geodatabase which include over 110 parameters associated to the 2697 KOs and some 20 parameters associated to the 5997 point data. Annex 4 also provides the summary value at national level of all parameters associated to the map. Many of these national level results were used as input to the SWEIS.

Main findings

The following maps (Figures 1 to 3) present few selected thematic aspects resulting from the WISDOM analysis. These are only few themes out of the vast “wood energy atlas” that can be mapped on the basis of the geodatabase. The selected themes refer to basic questions such as the balance and pattern of current fuelwood consumption and production, the production potential of woody biomass with reference to current forest management plans, the spatial distribution of existing wood industries and biomass systems, and an example of priority zoning combining several parameters of the geodatabase.

Figure 1 shows current fuelwood consumption/production situation. The map reports the balance between actual extracted wood from preferred fuelwood species (all non-timber assortments from hard broadleaved and Larch) plus the wood produced outside forests and the household consumption of fuelwood. The estimated national summary values are shown in Table 2 further below.

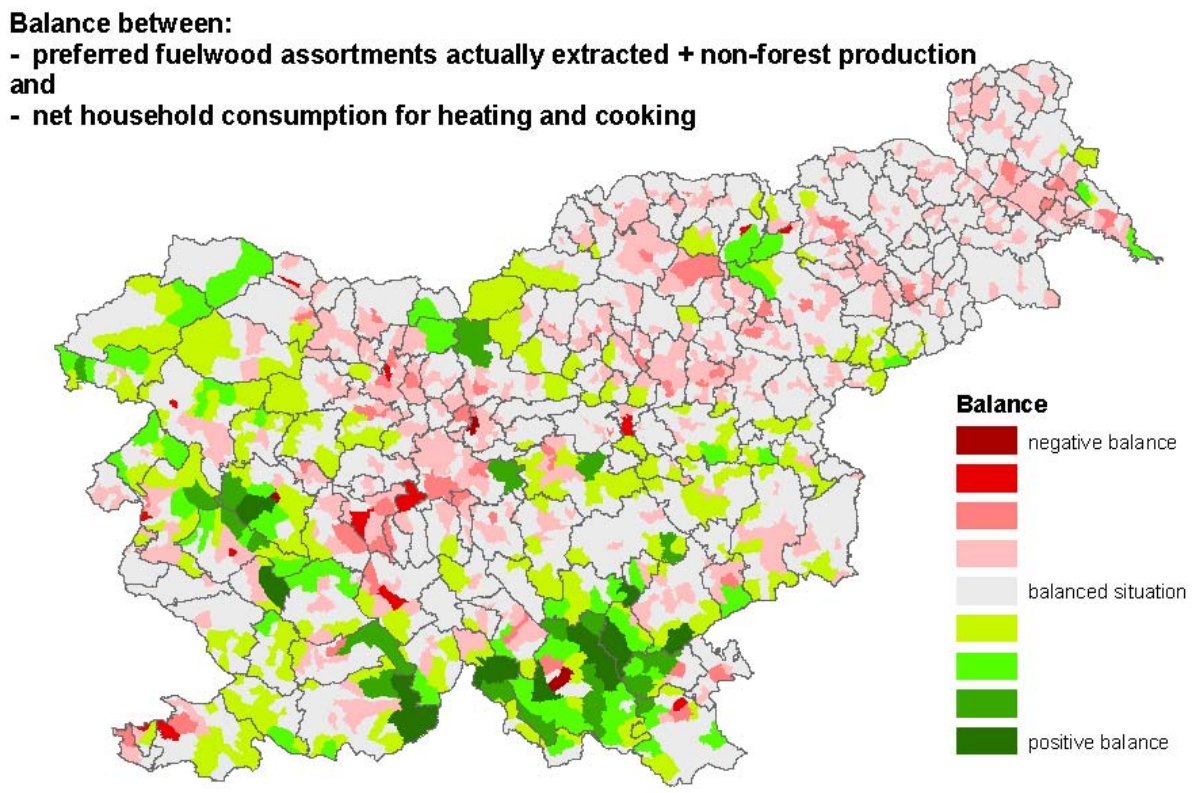


Figure 1: Spatial pattern of current fuelwood production/consumption situation.

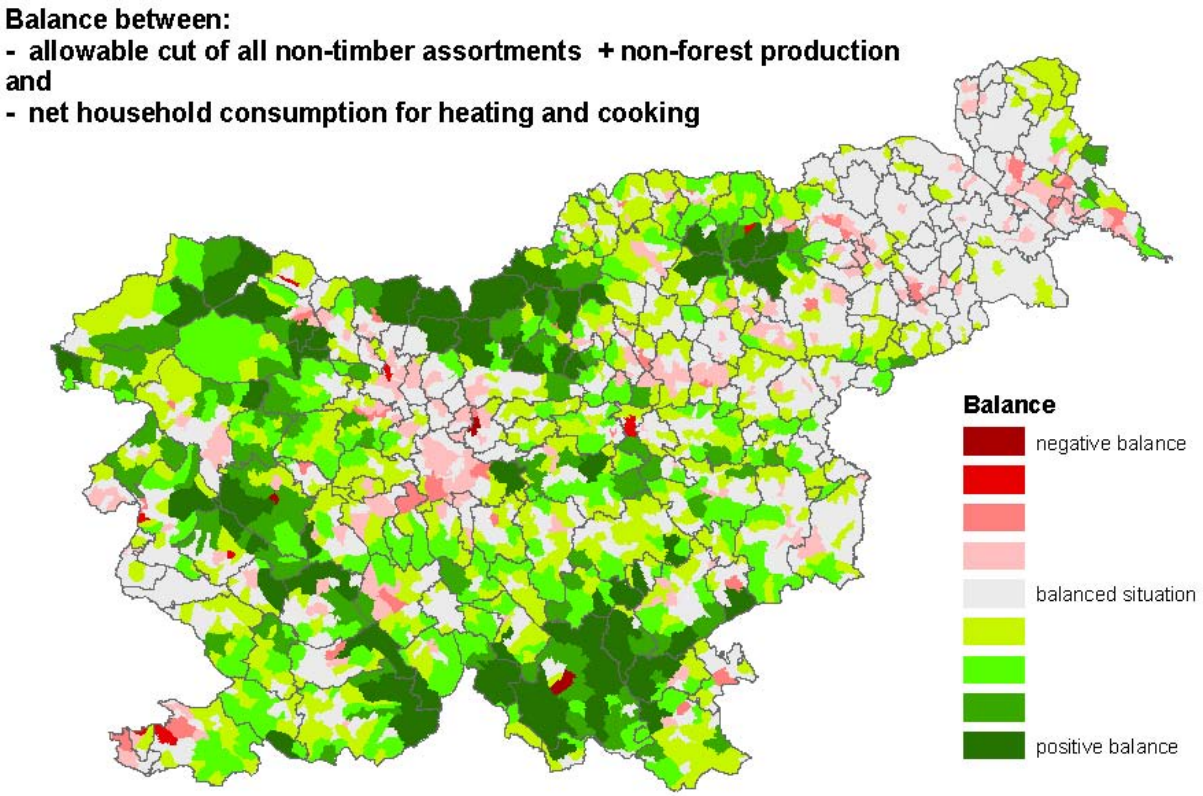


Figure 2: Spatial pattern of potential fuelwood production/consumption balance between current non-timber allowable cut plus the estimated non-forest productivity and household consumption. Overall balance is estimated to be over + 1.1 million m^3. The darker green areas indicate the locations with highest woody biomass surplus, where, for instance, new wood energy systems could be located.

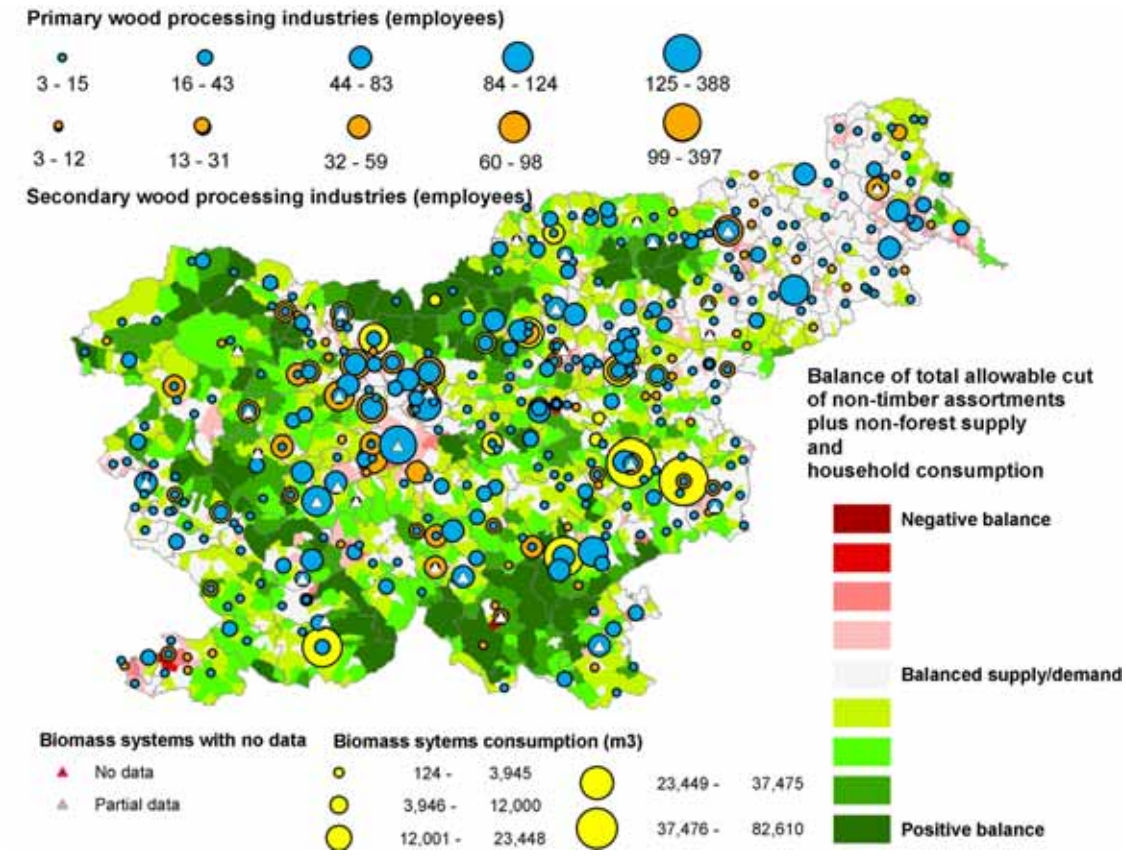


Figure 3: Distribution of wood processing industries and biomass systems on the background of the potential sustainable supply of woody biomass shown in Figure 2.

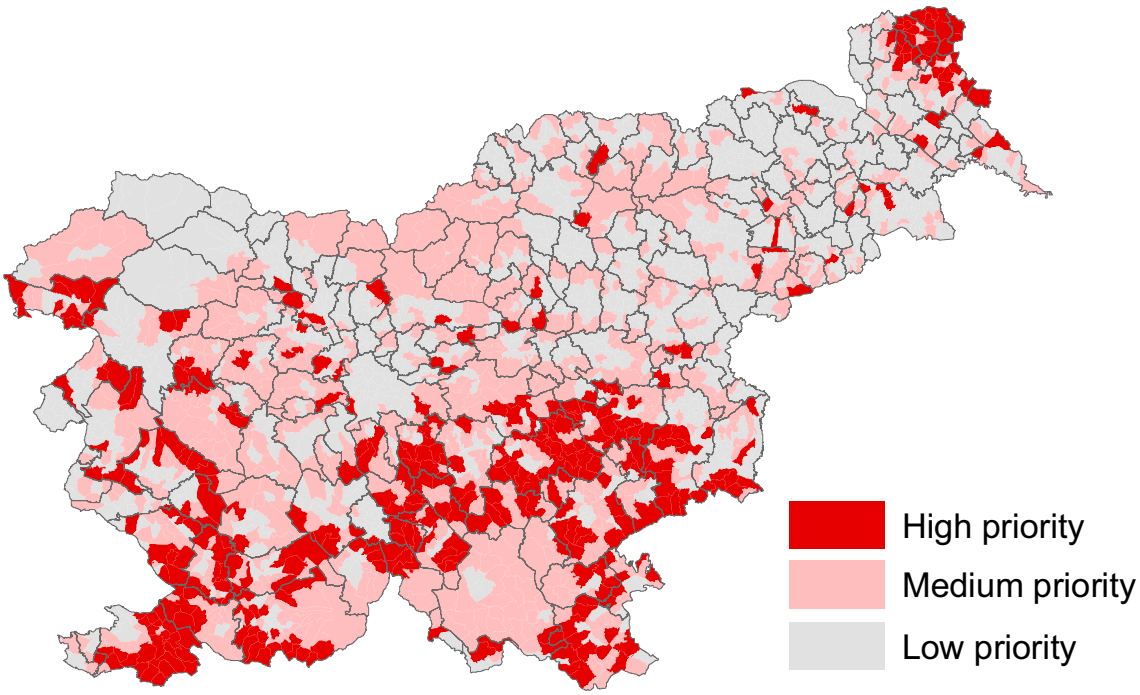


Figure 4: Example of priority zoning derived from the combination of three thematic elements: high property fragmentation; high wood surplus considering current local consumption and potential sustainable productivity; high fraction of forests at thinning stage.

Figure 2 shows the potential sustainable surplus of woody biomass on which the expansion of wood energy could be based. The map reports the balance between the total allowable cut of all non-timber assortments from all species plus the wood produced outside forests and the estimated household fuelwood consumption. The national summary value is shown in No. 2 in Table 2 (darker grey). This estimation is very conservative since it is based on a total allowable cut (timber and non-timber assortments) of less than 4 million m^3, while it is known that Slovenia forests have an annual increment above 7 million m^3. Therefore, the real amount of wood available for energy use (here estimated at 1,144 million m^3) could be more than doubled without interfering with the timber and fiber industries and remaining within the limits of sustainable forest productivity.

Figure 3 shows the distribution of biomass systems, including district heating systems, combined heat and power plants and other non-specified wood-based systems, as well as primary and secondary wood processing industries. Most biomass systems are fed by residues from wood processing industries and many of them are located within the industries themselves to supply part of the energy needed for their production processes. In order to visualize the areas suitable for the installation of new plants, the existing industrial plants are shown on the background of the potential sustainable supply of woody biomass (shown in Figure 2).

Figure 4 shows, as an example of priority zoning, the areas of the country most suitable for the implementation of field programs oriented toward: (i) the promotion of forest owners associations, (ii) the increase of woodfuel production and (iii) the carrying out of thinnings in overstocked forests and, consequently, the amelioration of future timber quality. These priority areas were determined through the combination of three aspects such as high property fragmentation, high wood surplus considering current local consumption and potential sustainable productivity, and high fraction of forests at thinning stage (early and late pole stages).

This dataset is meant to be used and reviewed by forestry and energy experts in order to validate the underlying assumptions and to keep them up-to-date. This in itself must be considered an important result of the WISDOM approach since demand and supply estimates are consistently combined for the first time and offer an unprecedented basis for inter-sectoral discussion.

Based on the current data stage of analysis, the following key findings may be highlighted:

- Approximately 1.9 million m^3 (mm^3) of wood were used as an energy source in Slovenia in 2002, of which 1.3 mm^3 is used by the household sector 0.6 mm^3 by the industrial sector--including biomass energy systems. It appears that there are two fairly independent woodfuel circuits: one household circuit that uses mainly fuelwood from forests and farmlands (and marginally charcoal) and one industrial circuit that uses mainly residues from wood industries and paper mills.

- According to Statistical Office of Slovenia the national fuelwood production for year 2002 was 280 000 m^3, which is only 22% of the consumption estimated by the project. Similarly, the assortment specifically classified as “fuelwood” in forestry databases represents only 17% (assortment’s allowable cut) of the volume actually used as fuel, although all foresters recognize that other non-timber assortments are also primarily used as fuel. These gross inadequacies in quantifying fuelwood production show in some way that the energy use is not adequately recognized in the national context. Most relevant, this situation misleads the analysis of forest role in the energy sector as well as that of national energy statistics.

- The forest product commonly used as fuelwood was grouped in the assortment category called “Non-timber assortments commonly used as fuel” (Table 1) which includes the non-timber quality assortments of several species. On average, some 840 000 m^3 of this assortments group were annually extracted in the period 1991-2001. At present, considering the higher extraction rate, the extracted amount is likely to be around 1 million m^3.

- Particularly relevant appears the ratio between the volumes actually extracted and the allowable cut, which seems to depend primarily on property fragmentation. This ratio was 0.6 over the period 1991-2001 (on average 0.54 in private forests and 0.76 in state forests) but in recent years it seems to have increased approximately 0.7.

- The standing volume in non-forest areas (including meadows, abandoned agriculture, agro-forestry, urban areas, orchards, etc.) amounts to some 11.5 million m^3, with an estimated annual

increment of some 400 000 m^3. From this resource, approximately 300 000 m^3 are believed to be used as fuel every year[7].

- The second assortment class "Non-timber assortments of all species" (Table 2) represents the potential wood energy supply for household and industrial use in the near future--if the actual extraction will be increased to match the sustainable production capacity or at least the conservative levels defined by forest managements' allowable cut.

In maintaining and strengthening the WISDOM geodatabase some thematic aspects that are now preliminarily covered should be further developed or completed (as described in the Recommendations section) and included in the next versions of the geodatabase.

WISDOM is conceived as a strategic planning tool to be maintained, deepened and, most important, used by wood energy planners. In this respect, the analytical conclusions and priority zoning so far defined should be considered as the first steps in the analysis of this sector and not the conclusion of a process. The priority zoning carried out, for instance; was an example of analysis rather than the definition of true priorities. Many other aspects can, and hopefully will, be mapped by wood energy planners using the WISDOM geodatabase.

2.2 SWEIS

In order to produce a first coherent overview of current levels of woodfuels production, import, export and consumption in Slovenia, WISDOM data was integrated with additional data from a wide variety of sources [2] [11] [12] [14]. This comprehensive dataset constitutes the Slovenia Wood Energy Information System (SWEIS), which is summarized in Table 1.

SWEIS data is complete for year 2002, for which all components could be assessed. Still missing are time series data for household and industrial consumption, which prevented the computation of total production and consumption estimates for the other years and the estimation of trends.

Estimates for 2002 were computed as follows:

- insertion of the available information on import and export;
- estimation of household consumption (see WISDOM analysis);
- estimation of industrial consumption;
- estimation of industrial production;
- insertion of charcoal production data;
- estimation of fuelwood production in non-forest lands (see WISDOM analysis);
- calculation of fuelwood production from forest resources.

Some values had to be estimated because specific fuelwood production statistics did not exist and took into consideration the fact that that fuelwood production is demand-driven and not independent. In fact, in a general national context woodfuel production is equal to woodfuel consumption (minus export plus import), since large accumulations and storage beyond the annual consumption are uncommon.

While Table 1 accounts for the wood used for energy in terms of cubic meters, highlighting the importance of this product for the forestry sector, it is also important to consider it in terms of energy and to evaluate the contribution of this sector to meet the national energy demand and to assess its future potential. In order to provide the first elements of analysis, Annex 7 gives the values of Table 1 converted into energy units.

A direct comparison between SWEIS energy estimates and the Slovenia Yearbook energy statistics cannot be done, since the energy balance does not report woodfuels individually but groups all renewables and municipal/industrial waste together. Again, like for forestry statistics, wood energy is seen

[7] These values represent the first estimation ever done of non-forest woody biomass. However, since the variance of tree cover outside the forest is extremely high, the margin of error is very wide and they should be considered indicative only.

as a minor item and receives little attention. It is essential and highly recommended that in future statistical surveys of both forestry and energy sectors specific attention be given to the production and consumption of individual woodfuels.

Table 1: SWEIS - Slovenia Wood Energy Information System. National level statistics. Values in '000 m^3.

	1995	1996	1997	1998	1999	2000	2001	2002
Production								(1,952)
Fuelwood								
Forests								1,012[3]
Other land uses								**276**
Industries (residues)	**722**	695	669	644	620	597	575	553
Charcoal[1]	**1.2**	**1.2**	**1.3**	**1.4**	**1.4**	**1.6**	**1.5**	**1.9**
Black Liquor	109	109	109	109	109	109	109	**109**
Import								(3)
Fuelwood	**12**			**10**	**17**	**2**	**1**	**1**
Charcoal[1]	**2.2**	**2.1**	**2.0**	**1.9**	**1.9**	**1.7**	**1.7**	**1.8**
Black Liquor								
Export								(60)
Fuelwood	**75**			**89**	**75**	**62**	**55**	**60**
Charcoal								
Black Liquor								
Consumption								(1,895)
Household Sector								
Fuelwood								**1282**
Charcoal[1]	**3.4**	**3.3**	**3.3**	**3.3**	**3.3**	**3.3**	**3.2**	**3.7**
Black Liquor								
Other Sectors (industrial, public, etc.)								
Fuelwood			**432**					500[2]
Charcoal								
Black Liquor	109	109	109	109	109	109	109	**109**

Notes:

Figures in bold represent reference values. Other figures are extrapolated values.

[1] Estimated wood used for charcoal production. Conversion factor: 1 t of charcoal = 6 m^3 of wood.

[2] Available 2002 data on 31 biomass systems total 391 102 m^3. Value tentatively expanded to 500 000 m^3 to include the 34 biomass systems for which consumption data was missing.

[3] The Fuelwood from forests was estimated as total production (total consumption + export – import) minus all other production values (Fuelwood from other land uses and industries, Charcoal and black Liquor).

Woody biomass potential

In addition to estimating consumption levels, which are essential to the development of the SWEIS, a comprehensive study was done, as part of the WISDOM analysis, to assess the current and potential sustainable woodfuel production and its spatial distribution. Specifically, the following aspects were analyzed in great detail:

- the actual and potential sustainable production, from Slovenia managed forests, of wood assortments of non-timber quality suitable for wood energy uses;
- the stocking and productivity of woody biomass on non-forest land uses, including abandoned farmlands, mixed agro-forestry systems, meadows, orchards, urban areas, croplands, etc.).

Table 2 presents the main results of the supply study and an estimation of various consumption/production balances in respect of different production scenarios.

In Slovenia there are two fairly independent woodfuel circuits [12]:

- a "household" circuit that uses mainly fuelwood (and marginally charcoal) from forests and farmlands, and

- an “industrial” circuit that uses mainly residues from wood industries and paper mills.

Table 2 refers to the first circuit, analyzing the relation between the forest/non-forest productivity of fuelwood assortments and household consumption.

Concerning the wood products actually extracted from the forests (points 3 and 4 in Table 2) there is an approximate zero balance between the household consumption and the production from forests (limited to the traditionally preferred wood assortments) and from other land uses. The negative value (- 164 000 m^3) is due to the low cutting rate of the 1990’s. Since the consumption estimate refers to year 2002, an attempt was made to update the “extraction factor” according to recent years’ data (where it seems to be significantly higher). Accordingly, recent extraction rates were estimated around 1 million m^3, thus balancing (together with the estimated non-forest fuelwood) the household demand.

The analysis shows that at current extraction rates some half million m^3 of wood could be used for additional energy applications. These applications would be primarily industrial because this surplus wood is mainly coniferous and hence not suited for household consumption [11].

Table 2: Fuelwood consumption/production balances between annual estimated household consumptions and annual fuelwood production from forests and other land uses (currently or potentially used as fuelwood). Values in ‘000 m^3.

Fuelwood Production				**Household Fuelwood Consumption**	
Forests			**Non-forest land uses**	**1,280**	
Allowable cut of all assortments (timber and non-timber)		3,927	394 [1]	**Balance** (production <minus> consumption)	
Allowable cut from management plans					
1 - Non-timber assortments commonly used as fuel (group BCD)[4]		**1,407**			**404**
2 - Non-timber assortments of all species (all conifers included)		**2,148**			**1,144**
Volumes actually extracted [3]	Avg 1991-2001	Recent cut rate	**276** [2]	Avg 1991-2001	Recent cut rate
3 - Non-timber assortments commonly used as fuel (group BCD)[4]	**840**	**~ 1,000**		**- 164**	**~ 0**
4 - Non-timber assortments of all species (all conifers included)	**1,283**	**~ 1,500**		**280**	**~ 500**
Actual cut of all assortments (timber and non-timber) . Ten-years average 1991-2001	2,366	2,800			

[1] Estimated Mean Annual Increment of woody vegetation in non-forest land uses.

[2] Exploitable volume estimated as 70% of Mean Annual Increment

[3] During the period 1991-2001 the actual cut was 54% of allowable cut in private forests and 76% in state forests). In recent years the cut amount reached approximately 2.8 million m^3 [11].

[4] See Annex 5 for explanation.

Shaded balances are shown in Figures 1 and 2 below.

Regarding the entire allowable cut (points 1 and 2) there is a potential surplus that ranges between 0.4 and over 1.1 million m^3. These surpluses must be considered as very conservative because they refer to an allowable cut of 4 million m^3 while it is known that the annual increment of Slovenia forests is above 7 million m^3 [11]. This means that the true sustainable potential could easily be well above 2 million m^3 per year without affecting forest sustainability or wood industries; on the contrary, a more intense exploitation for energy purposes, which would include the execution of thinning operations, would be highly beneficial for the health of the forests and for the quality of timber products.

Draft wood energy strategy

The results of the Information Component, along with the results from other project components on Economics and Institutional Aspects, were used at the end of the Project to formulate a proposal for a national “wood energy strategy” for the Slovenian Forestry Service, to be combined with other forestry and energy plans as well as international conventions and agreements approved by the Government.

The strategy formulated recommended increasing the national annual woodfuel production/consumption up to (at least) 3 million m^3 before the year 2020. In this way, wood energy could reach an annual contribution of 30 PJ to the national energy balance representing around 10% (at present around 7%) of the total primary national energy consumption.

It is important to highlight, however, that the major constraint to the full development of the wood energy potential of the country is not from the exploitable amounts of woody biomass, which appear definitely abundant. The main constraints are with the institutional settings, including the lack of a dedicated branch within the Forest Service, the lack of specific legal and regulatory measures, and with the low poor incentives for forest owners to implement management prescriptions. In this respect it is necessary to promote forest owners associations to combat property fragmentation and to raise forest owners’ economic interest by internalizing the multiple social, economic and environmental benefits deriving from an increased production of woodfuels.

3 WISDOM development

3.1 WISDOM methodology

WISDOM is a spatially-explicit method oriented to support strategic wood energy planning and policy formulation, through the integration and analysis of existing woodfuels demand and supply related information and indicators. Rather than absolute and quantitative data, WISDOM is meant to provide relative/qualitative values such as risk zoning or criticality ranking, highlighting, at the highest possible spatial detail, the areas deserving attention and, if needed, additional data collection. In other words, WISDOM serves as an ASSESSING and STRATEGIC PLANNING tool to identify priority places for action.

WISDOM is based on: a) the use of geo-referenced socio-demographic and natural resource databases integrated within a geographical information system; b) a minimum spatial unit of analysis at sub-national level; c) a modular, open, and adaptable framework which integrates information of relevance to wood energy from multiple sources; and d) a comprehensive coverage of woodfuel resources and demand from different energy users.

The use of WISDOM involves five main steps, as shown in the diagram in Figure 5:

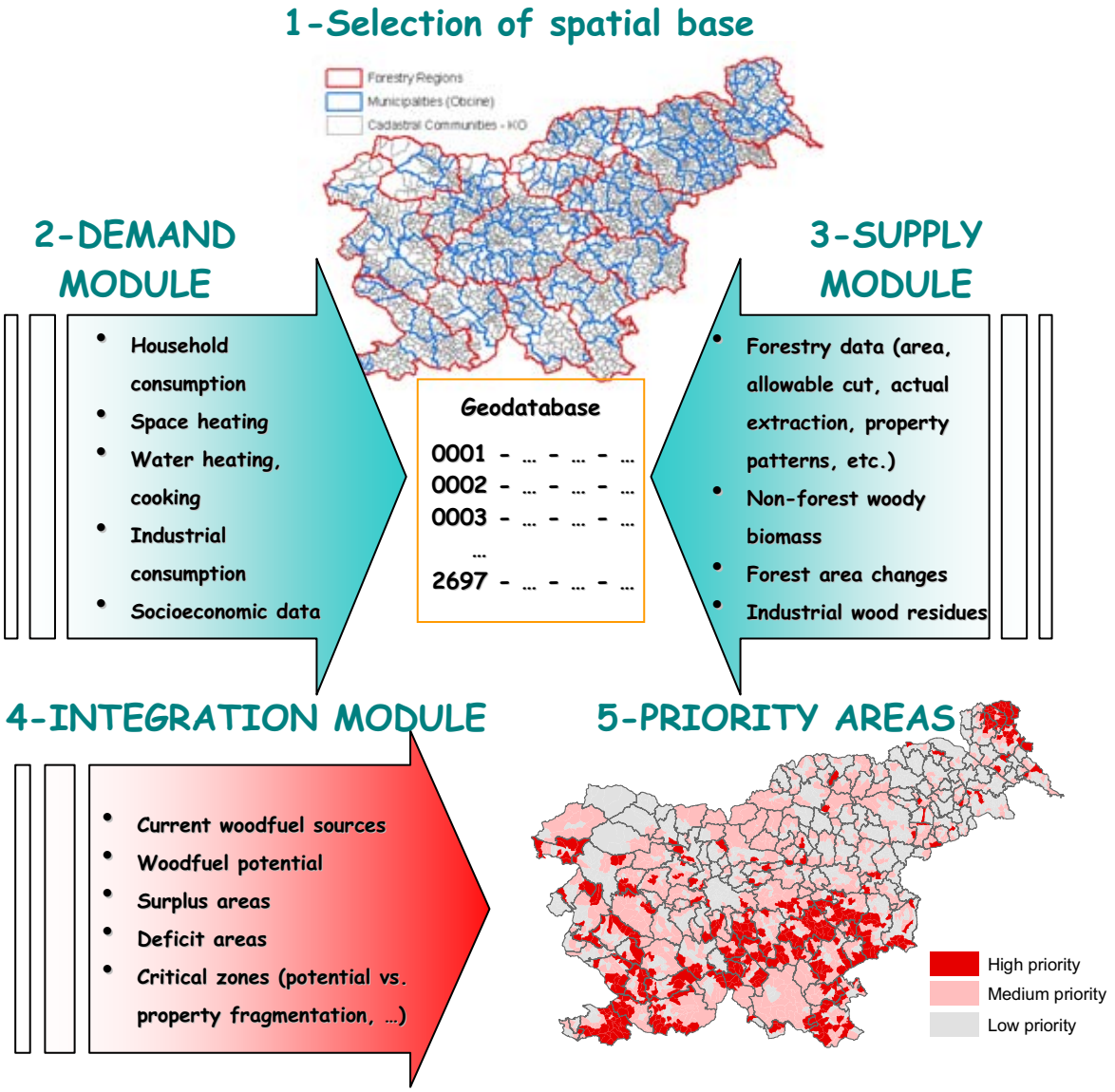


Figure 5: Diagram of the main steps in the development of WISDOM Slovenia.

The WISDOM method is meant to provide several benefits: a) to allow a consistent and **holistic vision** of the wood energy sector over the entire country and to help in determining **priority areas** for intervention; b) to allow the **definition of critical data gaps** resulting from the thorough review and harmonization of wood energy data; c) to promote **cooperation and synergies** among stakeholders and institutions (such as those from forestry, agriculture, energy, and rural development) - in this, WISDOM combats the fragmentation (of information, of responsibility) that so heavily limits the development of the sector – and, d) to allow the concentration of actions to circumscribed targets and thus to **optimize the use of available resources** (human, institutional, financial, and others).

Table 3 summarizes key aspects of Slovenia WISDOM and the development of its modules: **demand module, supply module**, and **integration module**. Figure 5 provides an overview of the main steps in the development of WISDOM Slovenia. All elements are presented and discussed in detail further below.

Table 3: Main features of fuelwood flows in Slovenia

Main features of fuelwood use in Slovenia	Slovenia is a biomass rich country. The large forest area (some 60 percent of the country) is accompanied by other land uses which are often rich of woody biomass and by consistent areas of abandoned farmland which revert to forest. The demand for woodfuels is concentrated on fuelwood (the production and use of charcoal being marginal) for household consumption in rural areas. A large part of fuelwood trade is informal as it is either collected by farmers in their own lands and forests or bought locally. The proportion of fuelwood coming from non-forest areas is estimated at over 20 percent of total household consumption. Industrial consumption, such as district heating systems, combined heat and power plants (CHP) and other industrial uses depend mainly on residues from wood processing industries [12]. These industrial uses are still rather marginal and sometimes characterized by obsolete technologies but may grow as viable energy policy alternatives.
Objectives of Slovenia WISDOM	To integrate the rich but fragmented information relevant for wood energy planning available in Slovenia in a spatially explicit dataset and to fill critical information gaps. To understand the true potential of wood energy as an economically and environmentally sound alternative or complement to fossil fuels. To identify the zones of the country most, or least, suitable to the development and implementation of wood energy projects.
Minimum Administrative Spatial Unit of Analysis	The spatial base was developed on **cadastral communities (KO)**, which represent the basis of Slovenia territorial structure. With 2696 units, the KO allows for a highly discreet spatial analysis and may be aggregated at municipal level and at any other reporting level. Additional layers are settlements (5997 points).
Demand Module	The main sources for the development of the module were: a) census data on dwellings that use fuelwood; b) estimated energy requirements for heating and other domestic uses; industrial consumption (partial data on 65 biomass systems).
Supply Module	Concerning forest areas, the basis of the module was the rich and regularly updated SFS database on forest compartments (over 65 000) and its new digital map, which provided information on stocking, annual increment, assortments production including fuelwood, actual cut quantities, ownership data, etc., all at KO level. Concerning the non-forest fuelwood sources, a specific survey was carried out, following a two-phase approach based on available ortophotos, the new Land Use Map (2002) and field sampling. Additional layers included are: i) forest area changes 1975 -2000; ii) distribution of wood processing industries.
Integration Module and priority zoning	A GIS was created using an ArcGIS platform. The geodatabase created includes all available consumption and supply parameters for each of the 2696 KOs and other point data. An additional set of variables was created integrating supply and demand, such as various balances of production/consumption values to indicate the pressure on fuelwood resources and potential surplus of fuelwood for advanced wood energy initiatives. The indexing of all the variables and indicators and further grouping will be conducted to rank KOs into various categories and priority levels. As example, priority zoning was done in respect of fuelwood production potential, property fragmentation and overstocked young forests at thinning stages.

3.2 Spatial base and geodatabase structure

The digital map of **Katastrske Občine (KO)** - cadastral communities – was used as spatial base. The KO layer is composed by **2696 units**, which represent the basis of Slovenia's territorial structure and can be aggregated (almost directly) to form municipalities, forestry regions, and practically all other administrative subdivisions (Figure 6, top map). KO subdivision is compatible with demographic and socio-economic data collected by the Slovenia Statistical Office.

Although the KO structure is very old, it is subject to continuous refinement. The most recent and consistent version of the KO map, updated in January 2003, was used as spatial base in the present study.

The forest compartment database contained KO reference codes, but the direct aggregation of forestry parameters at KO level could not be done since the correspondence with the digital KO map was not always consistent. To overcome this inconsistency the forest compartments map and KO map were intersected in order to establish a unique correspondence, as discussed under Supply module below.

Another important cartographic layer represents the distribution of human settlements (Figure 6 bottom map), composed by 5997 points providing basic demographic data and divided into urban and rural. The settlements were also used to locate wood processing industries, district heating systems and other wood-based industrial plants.

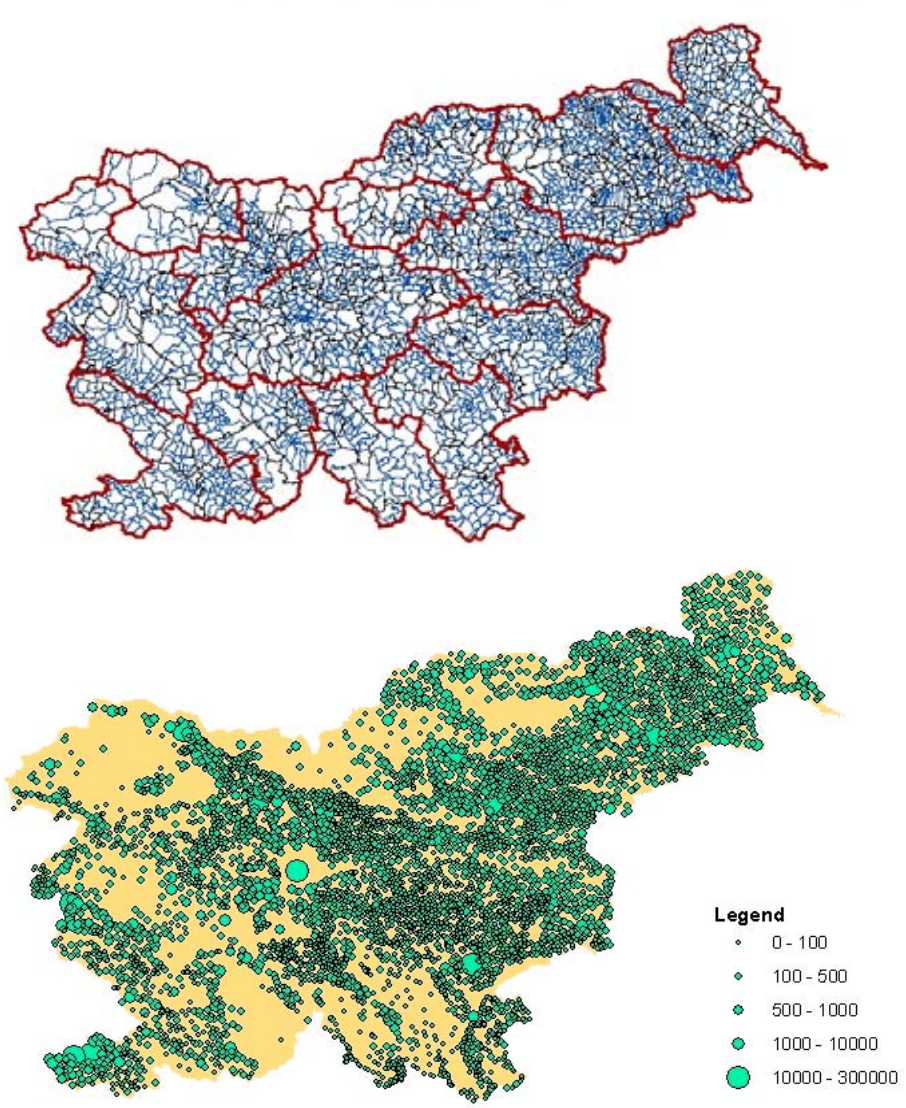


Figure 6. Top: Cadastral communities (2696) and forestry regions (14);
Below: Settlements (urban and rural) here shown by population size

The spatial and statistical data was structured in the form of a geodatabase, named KOWISDOM, which combined the spatial and statistical elements and allowed a convenient handling in both Microsoft Access (database features) and ESRI ArcMap environments.

Figure 7 shows a screen grab of Access and ArcMap while viewing the file KOWISDOM. The attribute table of the file is viewed as both Access table (left) and shapefile and related table of attributes (right). The thematic contents of the database, i.e. the attributes associated to the KOs, resulted from the development of the Demand, Supply and Integration modules described below. The values are listed in Annex 4.

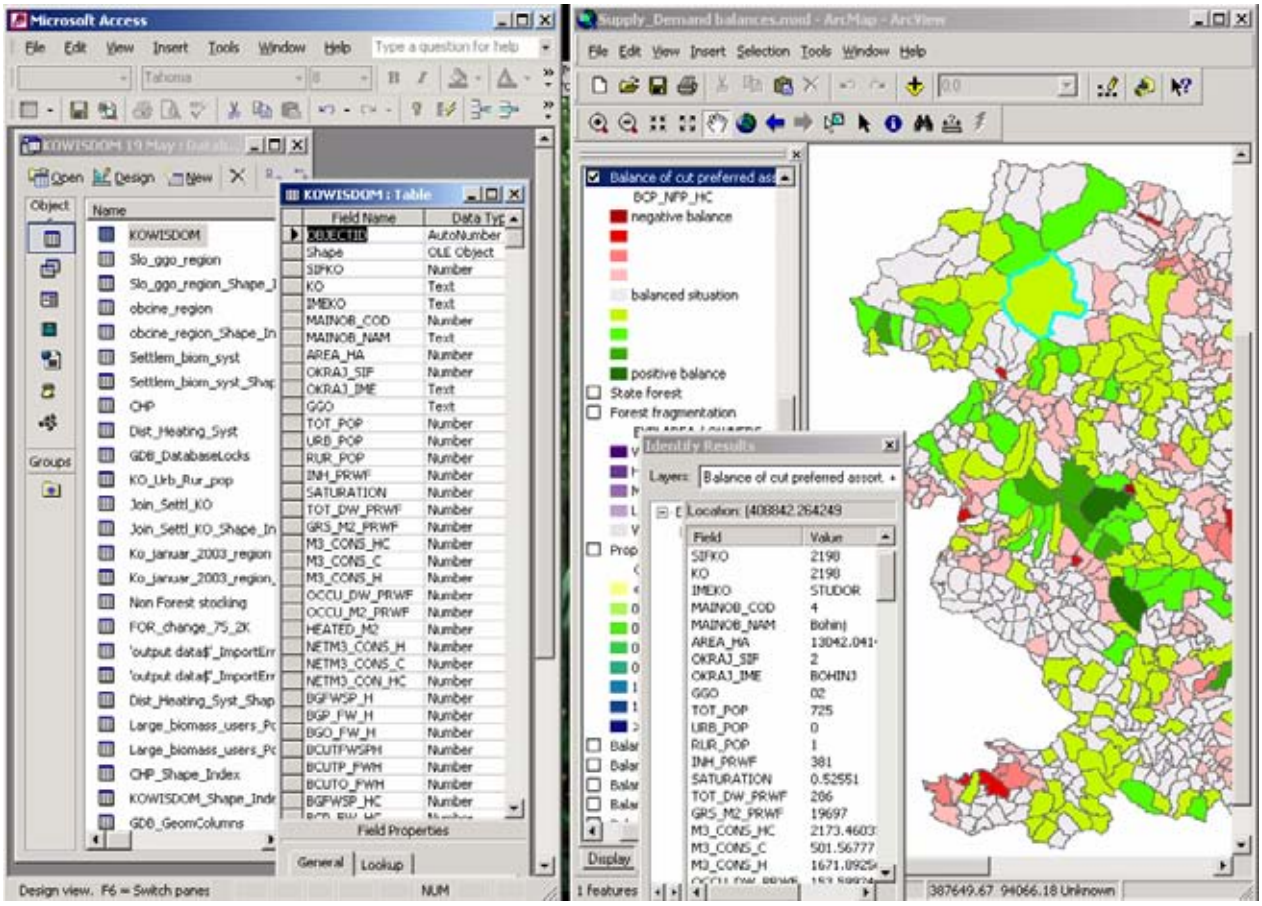


Figure 7: Screen grab of Access and ArcMap while viewing the KOWISDOM geodatabase

The attributes may be grouped in the following four categories:

Administrative elements: code and name of Cadastral Community (KO), Municipality, Region, and other administrative units; settlement locations with relative population data and urban/rural classification.

Demand-related variables: population variables (total fuelwood users, saturation, etc.); number and surface of dwellings using wood for heating; estimated household fuelwood consumption for house heating and cooking (original contribution of the current study); data (still rather incomplete) on existing biomass systems such as district heating systems, combined heat and power plants and other non-specified.

Supply-related variables: total and exploitable forest area; type and number of forest owners; total wood stocking and increment; area by forest phase development stage; forest area by accessibility class; annual allowable cut as well as actual extraction for main wood assortments and species group; area by land use classes (21 classes); estimated stocking volumes, increment and productivity of non-forest land use classes (original contribution of the current study).

Integration variables: This is a very open category where demand and supply-related variables may be combined. Key integration variables produced are (i) KO-level balances between fuelwood consumption and several supply scenarios and (ii), an example of priority zoning determined through the combination of surplus areas with ownership fragmentation and with forests at thinning stages.

3.3 DEMAND module

3.3.1 Household consumption

At present, almost the entire consumption of fuelwood in Slovenia is absorbed by the household sector and principally for space heating, for which this fuel provides about one third of the national energy demand as revealed by the 2002 census [13]. However, in spite of its relevance, reliable statistics on fuelwood consumption did not exist.

To fill this essential information gap, new consumption estimates[8] were therefore produced using the following data sources:

- Number of dwellings, surface and persons living therein that use wood as exclusive or primary fuel for space heating; fraction of occupied dwelling[9]. Source [13]
- Energy requirements for house heating (kWh/m^2) by type of apartment, construction year, level of insulation and maintenance. The estimated energy requirement for heating only used, as main reference, the weighted average for single-family houses (see Annex 3). Source [9].
- Estimated additional energy requirements for cooking and water heating. The total energy requirement for heating and cooking was estimated by adding 30% to the amount required for heating only (see Annex 3). Source [8].
- Energy conversion factors; average wood energy contents and conversion efficiency in Slovenia. Fraction of apartments' surface actually heated. Source [12].

Census data on dwellings allowed estimating the saturation of fuelwood use for space heating by KO, as shown in Figure 8.

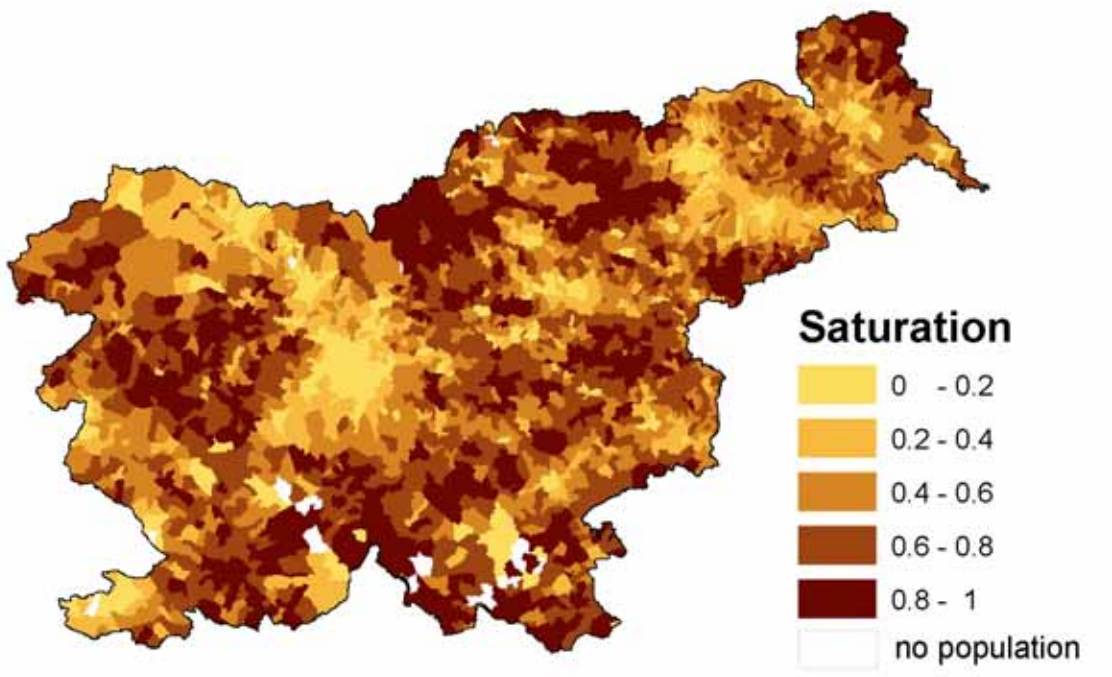


Figure 8. Saturation of fuelwood users (fraction of the dwelling using primarily or exclusively fuelwood for space heating).

[8] See Annex 3 : Household fuelwood consumption estimates

[9] See Annex 2: Summary of statistical data received from Statistical Office of Slovenia.

The data sets described above allowed for estimating the wood energy requirements described in Annex 3 and summarized in Table 4.

Table 4. Estimated wood energy requirements for space heating, water heating and cooking in Slovenia households.

		kWh/m^2	CUM/m^2	tons/m^2
Energy requirements per m2		208	0.11034	0.0800
Estimated energy/wood consumption by dwellings using wood as exclusive or primary fuel. The estimates refer to the actually heated fraction of occupied dwellings.				
		kWh	**CUM**	**tons**
Total Slovenia				
Estimated heated surface	11,618,290 m^2	2,416,604,390	1,282,017	929,462
		kWh/dw	**CUM/dw**	**tons/dw**
by dwelling	191,312 dwellings	12,632	6.7	4.86
		kWh/inh	**CUM/inh**	**tons/inh**
by inhabitant	594,934 inhabitants	4,062	2.2	1.56

Assumed wood energy efficiency = 65% = 1885 kWh/m^3 [12].

The spatial distribution of household fuelwood consumption for space heating, water heating and cooking in Slovenia households is shown in Figure 9.

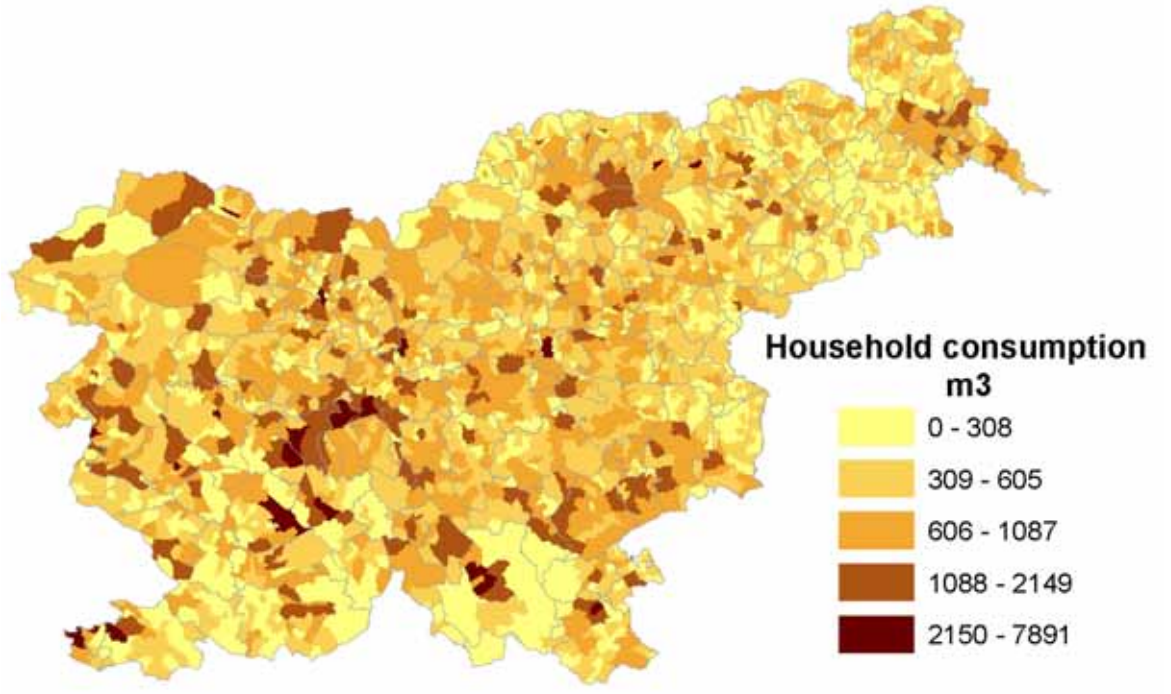


Figure 9. Fuelwood consumption by Slovenia households.

Recommended further developments

The estimates of household consumption may be refined to reflect climatic variations using KO-level data on winter temperatures and length of heating seasons. Relevant parameters may be obtained from the Office of Spatial Planning of the Ministry of Environment, Social Planning and Energy, which produces Temperature Zones maps.

In addition to the above, the Demand module should include historical data to analyze recent trends and to allow some projection estimates[10]. Unfortunately, this is not an easy task, since the previous censuses did not collect data on the types of fuel used for house heating.

3.3.2 Industrial consumption

The information available on industrial wood energy consumption [10] [12] was fragmented and recent data [2] largely incomplete. Such information was composed by data on 5 district heating systems, 5 combined heat and power plants (CHP) and on 55 industries that have wood-fed boilers of which 21 with some consumption details and 34 without details beyond their location[11].

Figure 10 shows the distribution of the biomass systems with some detail about the available information.

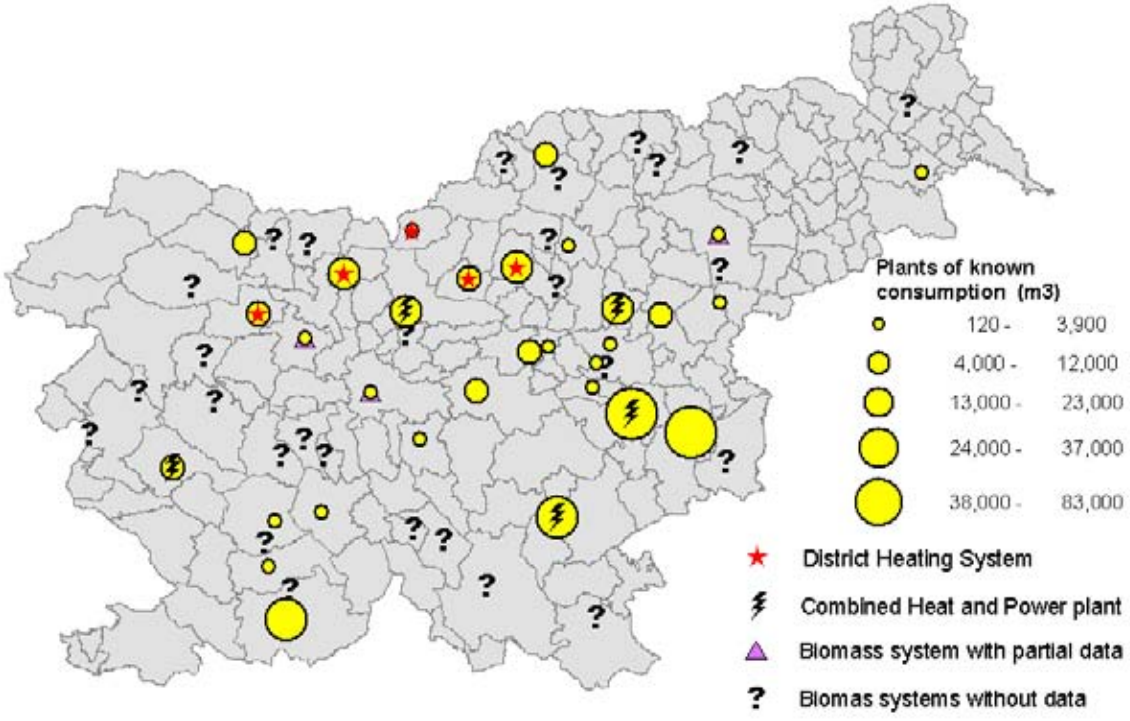


Figure 10. Distribution of biomass systems in Slovenia and available consumption data.

The total consumption from available biomass systems data at year 2002 amounts to some 390 000 m^3. This is incomplete since for many units the consumption is not yet known. SFI studies [10] estimated the total consumption in 1997 at 432 000 m^3.

[10] More information on fuelwood consumption would be generated after the completion of WISDOM component through the analysis of "fuelwood user profile" that was carried out by SFI using additional statistics from the census 2002 and from the census of agricultural holdings (2000) (see variables in Annex 2).

[11] Additional information on wood waste was generated by SFI after the completion of the WISDOM component of the Project (see Chapter "Project follow-up – WISDOM development"). However, since the response to the questionnaires sent out was not complete at the time of writing the estimated values were not replaced.

Considering this information and the fact that few systems were established after 1997, the value entered in SWEIS was tentatively estimated at 500 000 m^3.

3.4 SUPPLY module

3.4.1 Forestry data

In spite of the importance of forest products for energy use and in spite of the excellent existing data on forest resources and outputs, the official statistics fail to provide realistic data on fuelwood production in Slovenia. When we compare the figures of the Statistical Office of Slovenia on fuelwood production shown in Table 5 to the estimated consumption shown in Table 4 above it is evident that the former cannot represent the true amount of fuelwood produced from Slovenia forests.

Table 5: Statistical Office of Slovenia. Production of row wood categories ('000 m^3)

	1990	1995	1998	1999	2000	2001	2002	5-yr average
TOTAL	1790	1751	2132	2068	2253	2257	2283	2199
Logs	979	918	1001	992	1120	1144	1164	1084
Pulpwood	281	519	451	434	396	410	414	421
Other_industrial_wood	335	88	142	137	205	408	425	263
Fuelwood	**195**	**226**	**539**	**505**	**532**	**295**	**280**	**430**

Source [14]

It is apparent that 280 000 m^3 of fuelwood (or 430 000, if we take the 5-years average) cannot satisfy the needs of some 600 000 people [13] that use of wood for household heating, cooking and water heating (to consider only the household sector). Fuelwood production is definitely much higher than reported in official statistics but hidden under other categories.

In order to develop the supply module with reliable and detailed data, the original forest compartment databases were used [11]. These databases are maintained by the SFS for the approximately 65 000 forest compartments that compose Slovenia forests. Compartment data relative to the period 1991-2001 were aggregated at KO level to form the databases described in Annex 5.

Some important characteristics of Slovenian forests according to KO level statistics, such as forest cover, stocking and mean annual increment, are shown in figures 11 to 13.

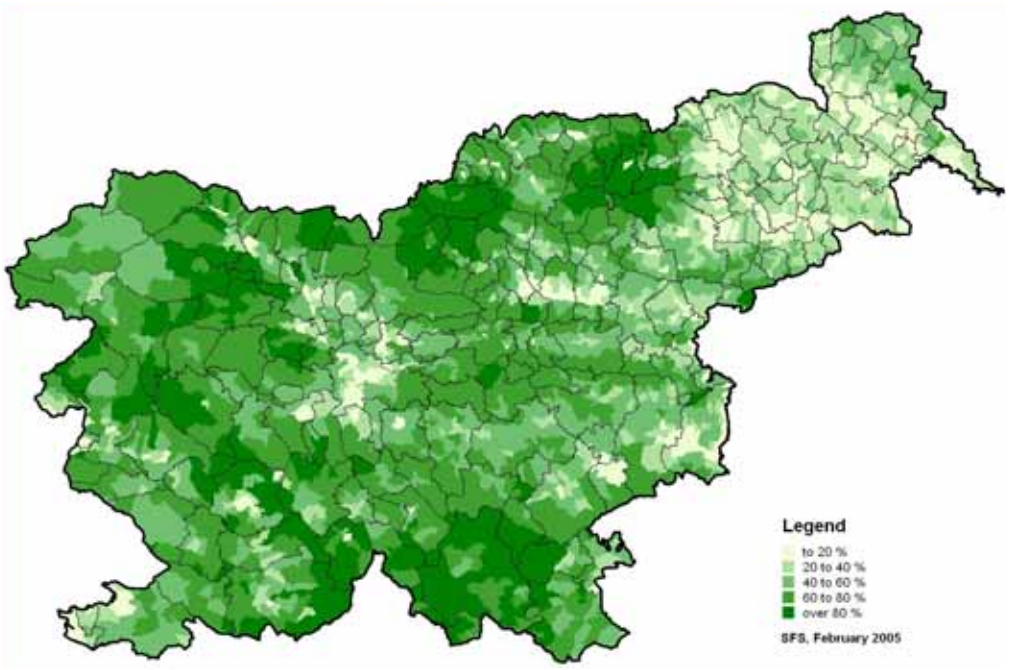


Figure 11. Share of KO surface covered by forest.

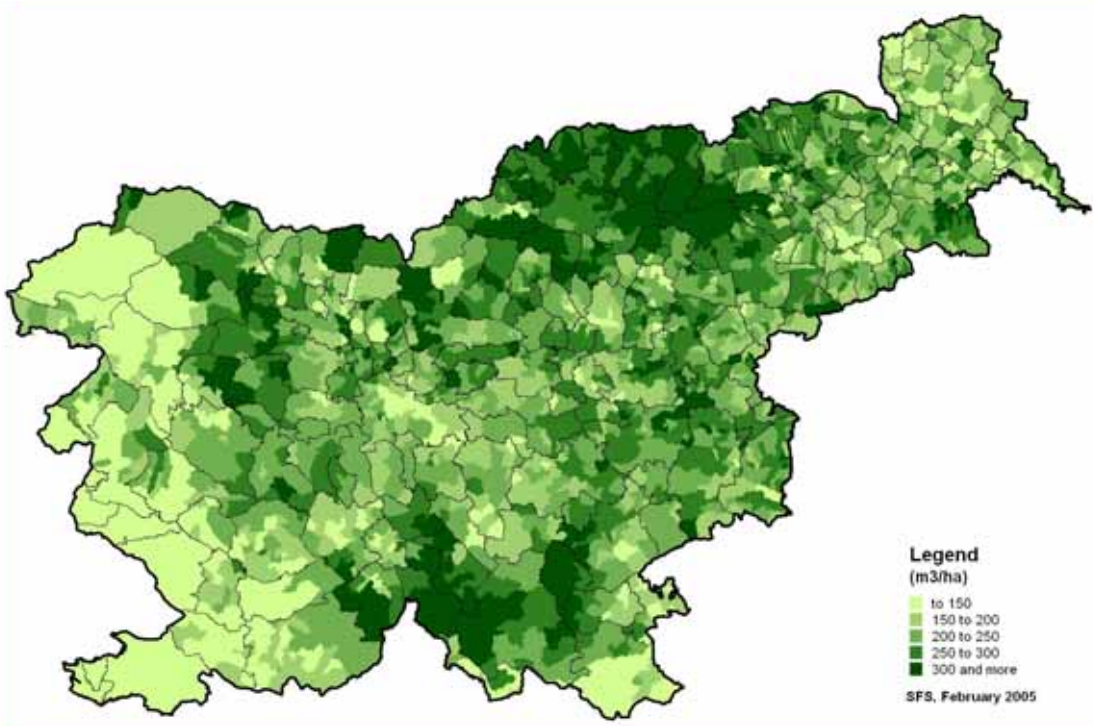


Figure 12. Average forest stocking – m3/ha of forest.

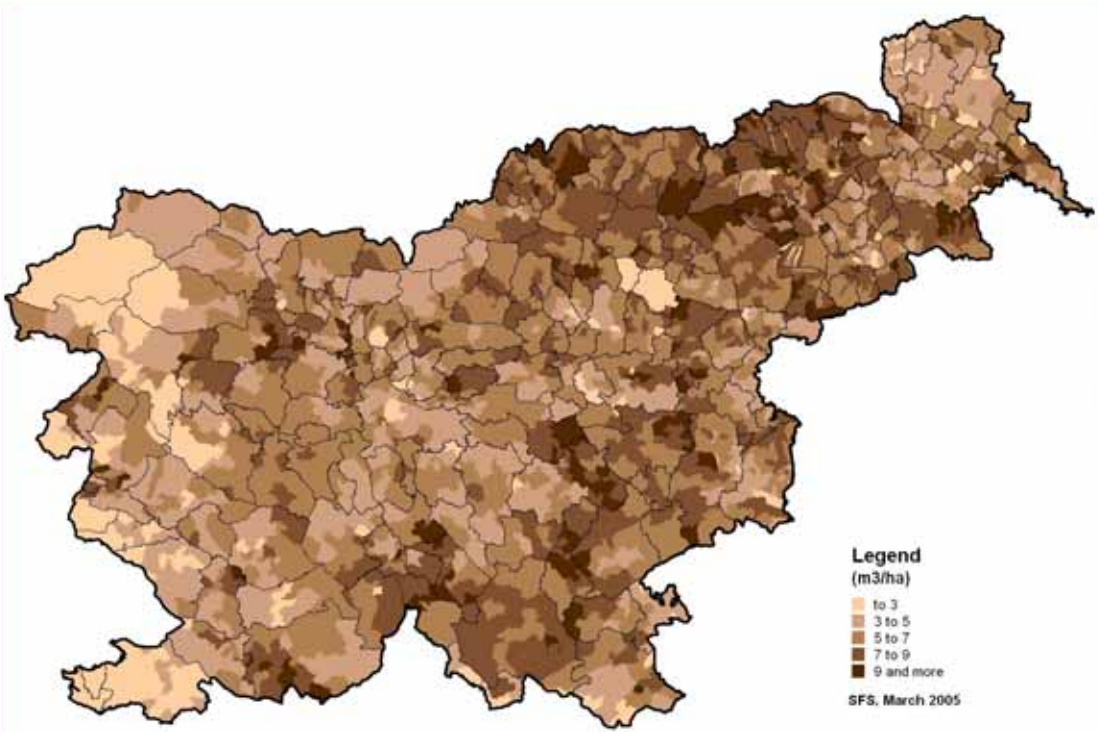


Figure 13. KO-level average of Mean Annual Increment (m3/ year / ha of forest).

Forest compartment databases maintained by the Forestry Service are extremely rich, with data on many aspects of Slovenia forests, including:

- total and exploitable forest area;
- type and number of forest owners;
- total wood stocking and increment;
- area by forest phase development stage;
- forest area by accessibility class;
- annual allowable cut as well as actual extraction for main wood products assortments and species group

This last dataset was the basis for the estimation of the amount of wood exploitable and actually extracted. The assortments considered, were the following:

- Fuelwood assortments from species group “Other hard broad leaved trees” (Carpinus, Ostrya, Fraxinus ornus, Robinia, Acer campestre, Sorbus, Quercus pubescens). This is the only assortment officially recognized as “fuelwood”.
- Non-timber assortments commonly used as fuel (including Larch, Beech, Oak, Chestnut, and other quality broadleaves – groups B, C, and D in Annex 5)
- Non-timber assortments of all species (all conifers included)

The first assortment (the one specifically classified as “fuel”) represents only a small fraction of the volume actually used as fuel estimated in the Demand Module (17% if we consider the allowable cut and 10% if we consider the actual cut). However, practically all foresters interviewed recognized that other non-timber assortments are also primarily used as fuel [11].

The second assortment class, i.e. “Non-timber assortments commonly used as fuel” represents today’s main “forest” fuelwood supply for household use. It is likely that In addition to the amount reported there is a certain amount of “informal” and unrecorded forest extraction.

The third assortment class “Non-timber assortments of all species” represents the potential wood energy supply for household and industrial use in the near future, especially if the actual extraction will be increased to match the sustainable production capacity or at least the conservative levels defined by forest managements’ allowable cut. The distribution of this assortment class is shown in Figure 14.

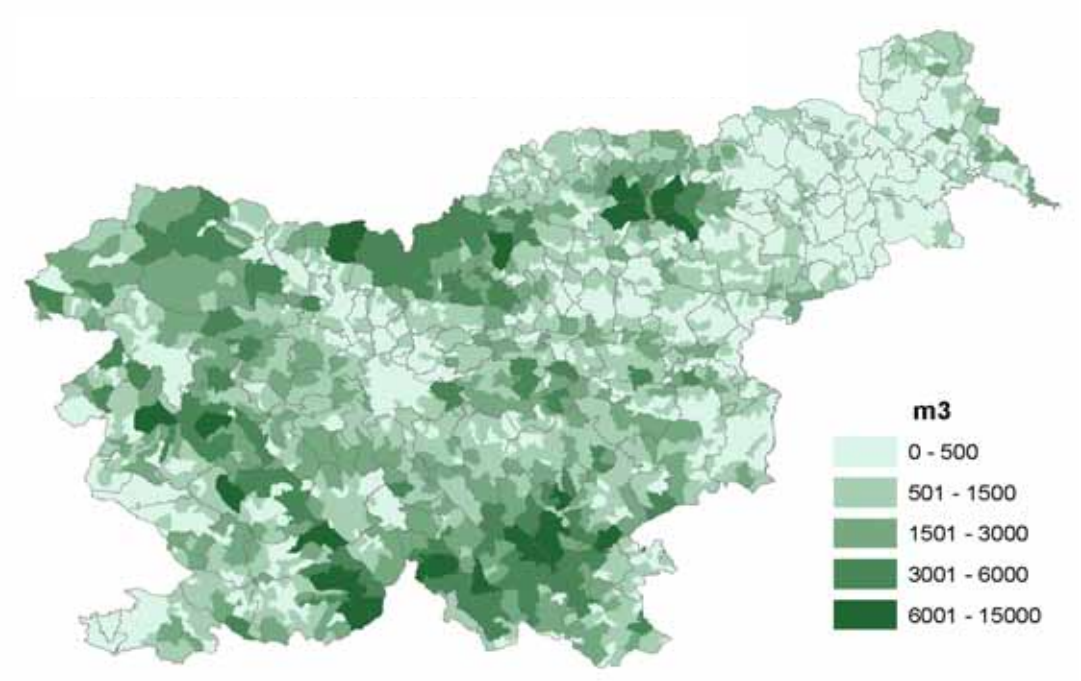


Figure 14. KO-level distribution of allowable cut of all non-timber assortment.

The volumes were estimates of both allowable cut and actually extracted amounts. The ratio between actual extraction and the allowable cut depended mainly on ownership factors. Over the period 1991-2001 the ratio appeared to be, on average, 0.54 for privately owned forests, rural communities and religious institutions and 0.76 for state forests [11]. Total values for all categories are given in Annex 4. Table 6 below reports the aggregated values of most relevant forest production parameters. These values are reported, in comparison with consumption levels, in Table 2 in the previous chapter.

Table 6: The most important data on the supply of fuelwood from the forests on the State level

Forests	
Total forest area	1.185.306 ha
Exploitable forest area	1.104.794 ha
Allowable cut by management plans	
Non timber assortments commonly used as fuel (group BCD)*	1.407.000 m^3
Non timber assortments of all species (all conifers included)	2.148.000 m^3
Volumes actually extracted (average over the period 1991-2001)	
Non timber assortments commonly used as fuel (group BCD)	840.000 m^3
Non timber assortments of all species (all conifers included)	1.283.000 m^3

Notes:
*See Annex 5 for explanation.

Among the many perspectives that this rich dataset provides, a particularly interesting one concerns forest ownership, which allows for the distinction of forest area by levels of property fragmentation shown in Figure 15. Fragmentation of forest properties poses many problems for the implementation of forest policies, as many owners have marginal interest in their forest lots or simply do not know where they are. In fact, the efficiency of execution of allowable cuts seems inversely related to the fragmentation of forest ownership.

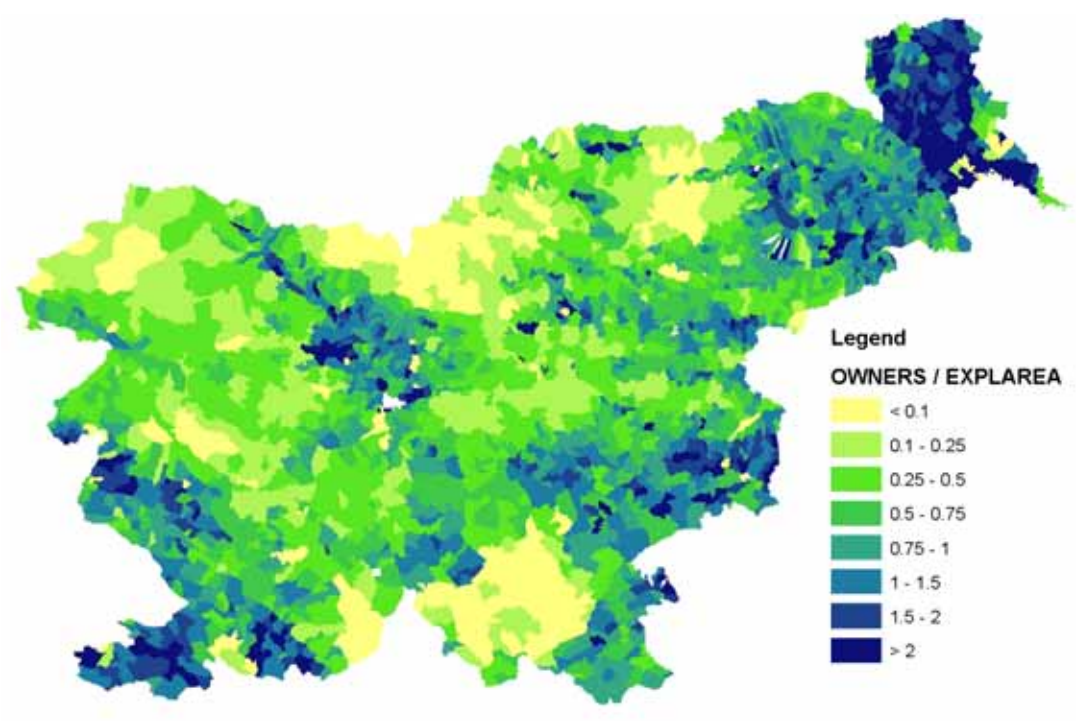


Figure 15 : Forest ownership fragmentation. Number of forest owners per hectare of exploitable forest co-owners are not considered).

3.4.2 Changes in forest area, stocking and increment

The recent study on forest area change over the period 1975-2000 [4] estimated that Slovenian forests have grown at an average annual rate of 0.4 %. The area of forest has increased of over 116 000 ha in 25 years, passing from 1 085 000 to 1 201 000 ha. The spatial pattern of forest area change is shown in Figures 16 and 17, the first in absolute terms (ha of change) and the second in relative terms (percent of KO area). The increase in forest area is due mainly to abandoned marginal farmlands.

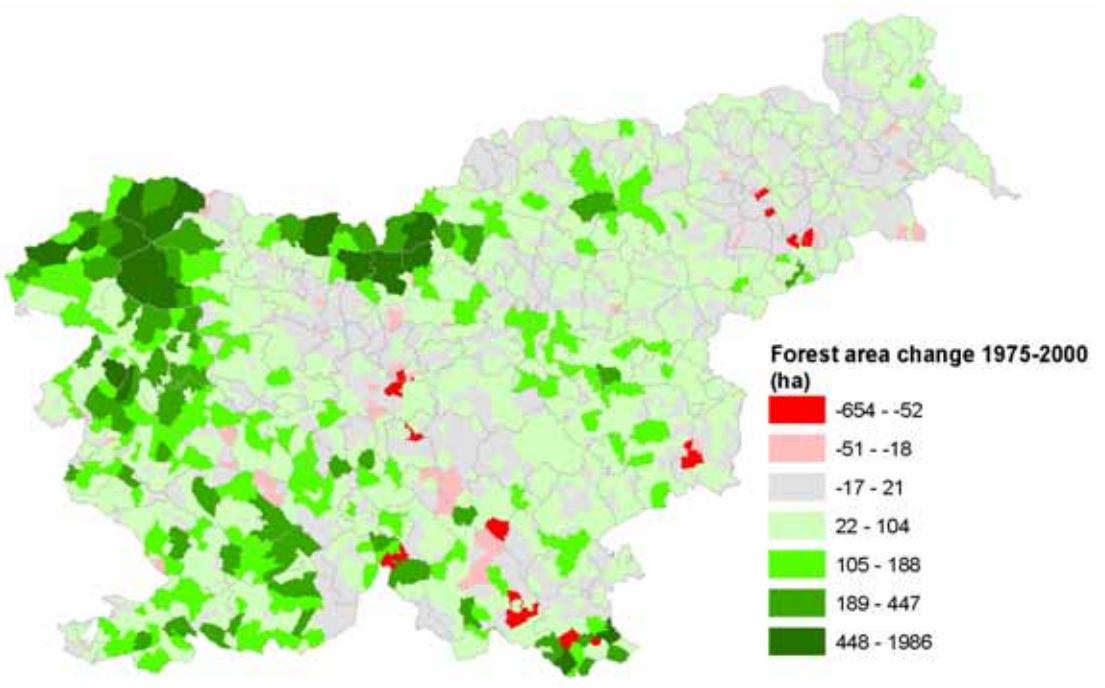


Figure 16 : Forest area change over the period 1975-2000.

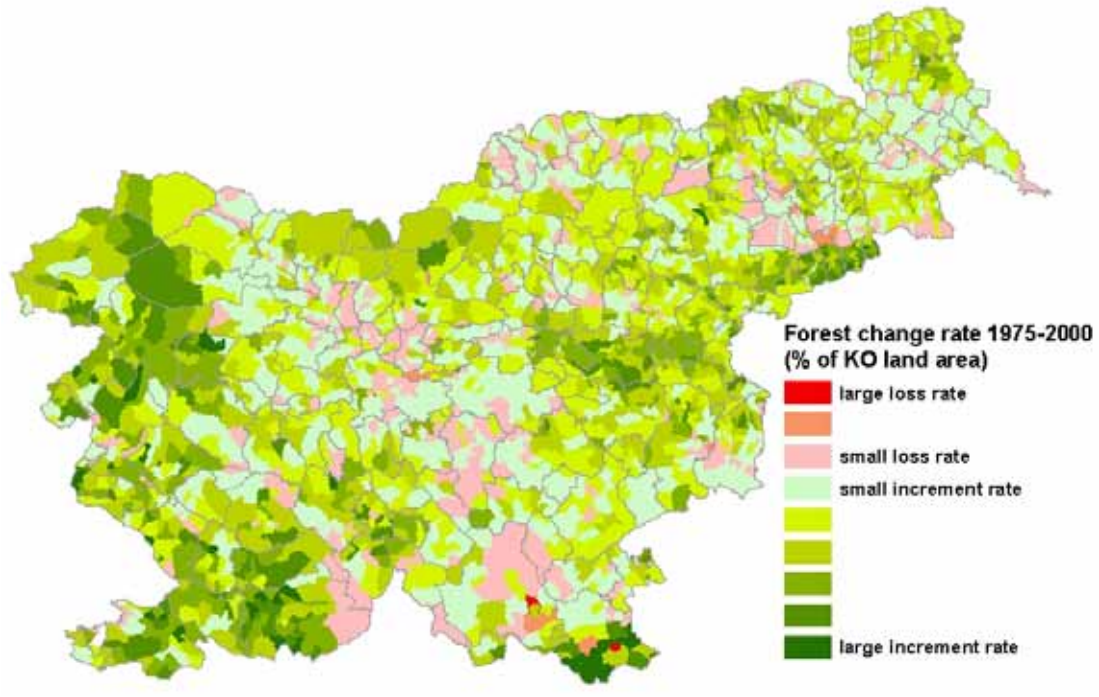


Figure 17 : Forest change rates as percent of KO land area over the period 1975-2000.

Other important aspects that strengthen the potential sustainable supply of fuelwood in the years to come are the steady growth in forest stocking, which grew from 207 million m^3 in 1990 to 286 million m^3 in 2003, and the similar growth of the mean annual increment, which increased from 5.3 million m^3 in 1990 to 7.3 million m^3 in 2003 [11] (Figure 18).

In fact, the current allowable cut, which is the basis of the sustainable productivity assumed in this study, is very conservative; it represents less than 60% of the estimated annual increment.

It can therefore be assumed that the potential supply of woodfuels could more than double today's extracted volumes without limiting the timber industry or affecting the growing stock. On the contrary, fuelwood production especially through thinning operations would have a positive effect on forest health condition, on stands resistance to extreme weather conditions and on the quality of timber products.

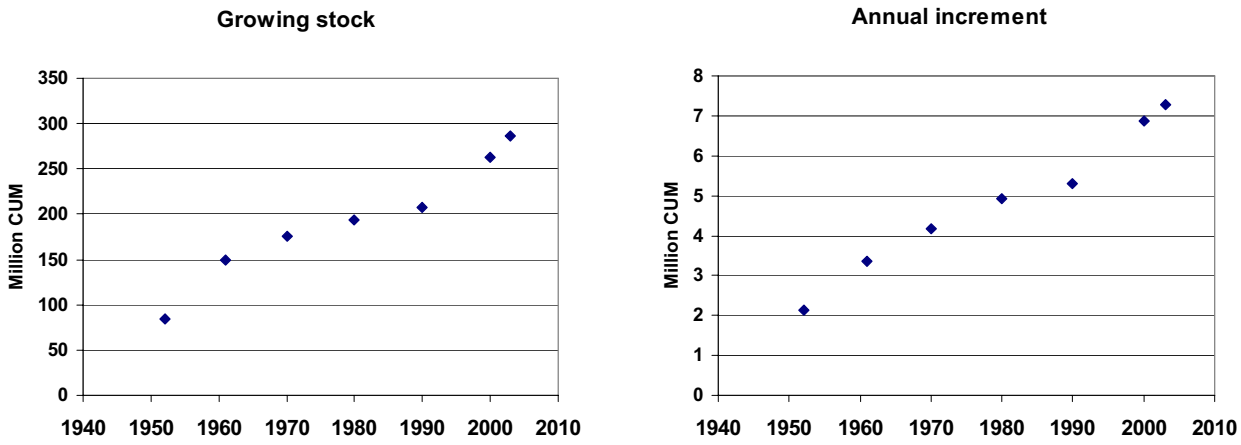


Figure 18 : Change of growing stock and mean annual increment.

3.4.3 Wood stocking and productivity in non-forest classes

Slovenian landscape is rich in woody biomass both within and outside forest areas. In addition, dense natural vegetation builds up in marginal abandoned farmlands in a continuous process that produces a net increment of the country's woody biomass resources. However, although it is known that a significant part of fuelwood for household use is collected by farmers in their own lands, no information existed on the stocking and productivity of non-forest areas or on the current and potential role of these areas in planning sustainable wood energy systems.

This item represented a major information gap in the Supply Module. In order to acquire basic reference values, and therefore to fill such information gap, a survey of non-forest areas was implemented using the recent Slovenia Land Use Map, ortocorrected aerial photographs and field measurements.

A description of the design, sampling scheme and results of the non-forest biomass survey is provided in Annex 6, while summary results are given in Table 7.

Slovenia Land use map

The recent land use map produced by the Ministry of Agriculture (2002) represented excellent background information. Its most immediate application was in the non-forest biomass survey, where it constituted the basis for the stratification and for the distribution of sampling units as described in Annex 6.

The digital map presented a very detailed spatial resolution and included the identifiers of the ortophotos that were used to create it and for the survey of non-forest biomass. In total, the map had over 650 000 land units (polygons). The 21 land cover classes of the map are described in Annex 6.

Table 7: Summary results of non-forest woody biomass survey

Code	Land use classes	Total area (ha)	Mean Stocking		Mean Increment		total stocking	total increment
			m^3/ha	CV%	m^3/ha/yr	CV%		
1100	Fields and gardens	213,985	3.0	119.56	0.10	121.69	649,466	21,958
1221	Intensive orchard	5,049	33.1	78.84	1.12	79.53	167,004	5,675
1222	Extensive orchard	19,849	32.1	48.94	1.14	47.83	637,212	22,591
1310	Intensive meadow	159,652	8.5	82.43	0.28	85.27	1,358,629	44,579
1322	Extensive meadow	187,930	19.5	73.74	0.67	73.77	3,670,979	126,499
1410	Re-growth on old farmland	25,246	57.4	63.11	2.16	59.84	1,449,435	54,498
1500	Mixed use (agric / forestry)	18,953	94.6	48.82	3.30	46.58	1,792,963	62,624
3000	Urban and built up areas, roads	108,194	15.6	80.44	0.51	83.75	1,691,725	55,430
		738,858	15.5		0.53		11,417,413	393,854

The results achieved give us the first objective estimation of wood stocking and annual increment outside forest areas.

Inevitably, due to the very heterogeneous character of non-forest landscapes, the variability is very high, as shown by the coefficients of variation close to 100% for several classes (which means that the standard deviation and the mean have similar values). Preliminary statistical analysis indicates that the confidence interval, calculated through logarithmic transformation at 90% confidence, ranges between 0.3 and 26 m^3/ha for stocking (mean 15.5) and between 0.12 and 3.21 for the increment (mean 0.53).

The productivity, in terms of fuelwood volume annually exploitable, has been estimated as 70% of the annual increment, which gives a national total of some 276 000 m^3/ha/year. The spatial distribution, by KO, of the estimated fuelwood productivity is shown in Figure 19.

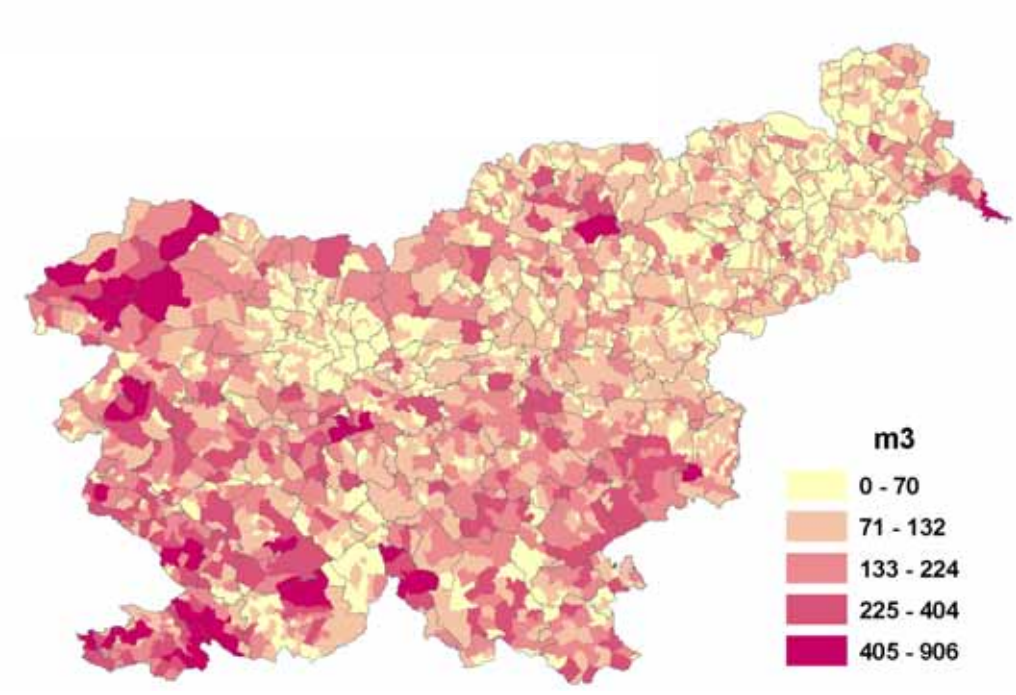


Figure 19 : Fuelwood productivity in non-forest land use classes.

3.4.4 Wood residues

The best available information on wood residues from forest industries and their use for energy is in the 1998 study by SFI [10], which provides summary data with reference year 1995. For that year the total annual production of wood residues was estimated at 722 000 m^3. The new data on wood industries that could be acquired in the frame of the project was limited to number of employees of primary wood industries (sawmills) and secondary wood industries (mainly furniture making) by settlements. This dataset is mapped in Figure 20.

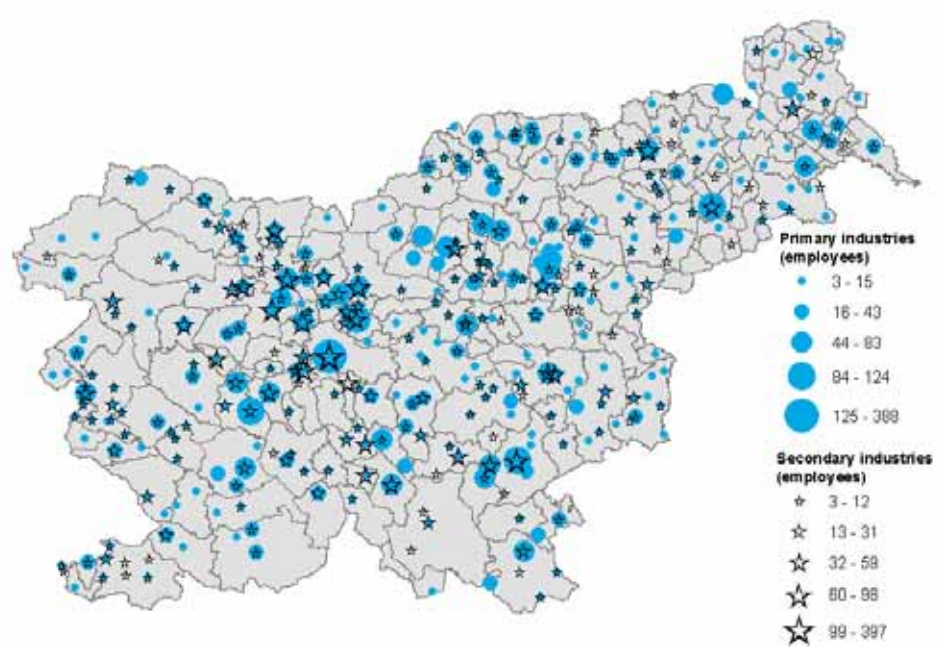


Figure 20 : Distribution of primary and secondary wood processing industries.

In the near future there will be considerable detailed data on wood residues and other waste material, as a result of the full implementation of Government prescriptions (and EU regulations). For the time being, however, the information available is insufficient for a spatial analysis of residue production and consumption. In qualitative terms it is known that most residues are for industrial consumption, mainly by biomass systems within the wood processing industries or by district heating systems.

In the development of SWEIS the production of wood residues after the 1995 reference date [10] was estimated to decrease with direct correlation to the reduction trends of industrial wood products, as reported by the Slovenia Statistical Office [14]. Accordingly, the production at year 2002 was tentatively estimated at some 553 000 m^3.

3.5 INTEGRATION module

3.5.1 Supply / Demand balance

The integration module focused on the analysis of the supply/demand balance between fuelwood consumption and forest/non-forest production.

More specifically, the analysis concerned the KO-level balance between:

- household fuelwood consumption and
- several supply scenarios determined by current and potential forest and non-forest productivity. Key parameters used were:
    - actually extracted vs. allowable cut as per management plans;
    - wood assortments and species groups commonly used as fuelwood vs. assortments and species potentially used as fuelwood (always limited to non-timber resources).

KO-level balance statistics were included in the WISDOM geodatabase and summarized in Annex 4.

The results, at national level, of the balance analysis and its possible scenarios are discussed in Chapter 2: “Results and Findings”. In the same Chapter, Figures 1 and 2 show the maps representing the geographic pattern of resulting surplus and deficit conditions of the two most representative scenarios:

- The current fuelwood consumption/production situation. The map reports the balance between the actually extracted wood from preferred fuelwood species (all non-timber assortments from hard broadleaved and Larch) plus the wood produced outside forests and the household consumption of fuelwood.
- The potential sustainable surplus of woody biomass on which the expansion of wood energy could be based. The map reports the balance between the total allowable cut of all non-timber assortments from all species (including assortments and species not used as fuelwood in households) plus the wood produced outside forests and the estimated household fuelwood consumption.

Table 2 in Chapter 2 summarizes consumption and production values and derived national level balances.

Since the information on industrial woodfuel production and consumption was still partial, the analysis was limited to supply/demand balance related to household consumption and forest/non-forest productivity.

On the other hand, this limitation did not seem to reduce the validity of the analysis done and the conclusions achieved for the household sector. In fact, as discussed before, there are two fairly independent woodfuel circuits: a “household” circuit that uses mainly fuelwood (and marginally charcoal) from forests and farmlands (the one represented by the balance analysis) and an “industrial” circuit that uses mainly residues from wood industries and paper mills.

To bridge between these two circuits and to study the potential for industrial wood energy development, the analysis focused on the determination of (i) the total woodfuel potential according to current forest management plans, and (ii) the zones of the country where there is a significant biomass surplus (after having satisfied household needs) that could feed district heating systems, power generation systems or other industrial plants.

3.5.2 Priority zoning

As example of the power of the WISDOM geodatabase to assist in operational and strategic planning, one priority zoning analysis was carried out on a theme, arbitrarily selected, among the many that may interest forestry and wood energy planners.

The scope of the priority analysis was to identify the areas of the country most suitable for the implementation of field programs oriented towards: (i) the promotion of forest owners associations, (ii) the increase of woodfuel production and (iii) the execution of thinning in overstocked forests.

The priority zoning was determined through the combination of the following three aspects:

- high wood surplus considering current local consumption and potential sustainable productivity (see Figure 2),
- high fragmentation of forest property (see Figure 15), and
- high fraction of forests at early and late pole stages, which are the stages of forest growth that require thinning operations (see Figure 21).

Priority areas were determined by means of an indexing approach in which the range of values of each thematic aspects was first ranked into 5 categories, reflecting a priority level in respect of the problem under analysis (rank 1= low priority; rank 5= high priority).

In the example carried out, the following indices were created:

- Supply/demand balance index: (higher (positive) balance = 5; lower (negative) balance = 1)
- Property fragmentation index (high fragmentation = 5; lower fragmentation = 1)
- Thinning stage index (higher fraction of forest at pole stage = 5; lower fraction = 1)

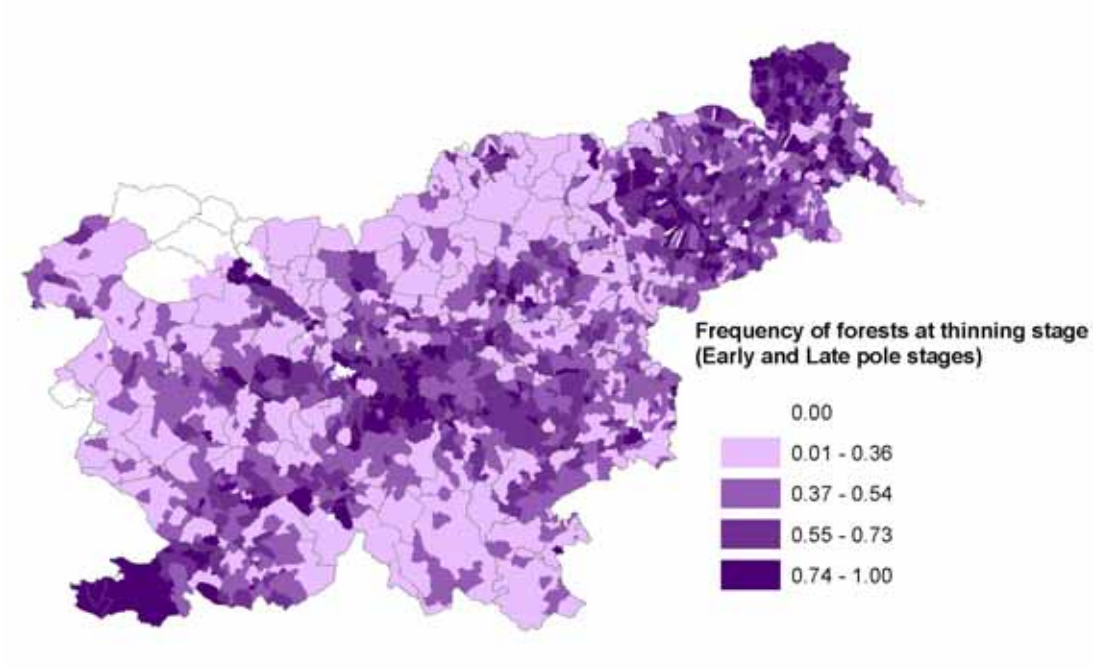


Figure 21 : Fraction of KO forests requiring thinning operations.

The combined index, which may be called Thinning Priority Index (TPI) was calculated as follows:

$$TPI_j = \sum_{1}^{3} I_i * P_i$$

where,

TPIj = thinning priority index for each KO "j"

I_i = index for each of the 3 variables used in the analysis, ranging from 1 to 5

P_j = weights, set to 1 in this case

The resulting TPI was again ranked into 3 levels, where the new "high priority" index grouped the areas with high indices in respect of all three parameters. The thematic map resulting from this analysis is shown in Figure 4, Chapter 2: "Results and Findings". The map provided a delineation of priority KO for the implementation of field programs geared towards solving the problem of "undone thinnings" through the promotion of owners associations and the increase woodfuel production.

As discussed earlier, WISDOM is conceived as a strategic planning tool to be maintained, deepened and, most important, used by wood energy planners. In this respect, the analytical conclusions and priority zoning so far defined should be considered as the first steps in the analysis of this sector and not the conclusion of a process. The priority zoning carried out, for instance, was an example of analysis rather than the definition of true priorities. Many other aspects can, and hopefully will, be mapped by wood energy planners using the WISDOM geodatabase.

4 SWEIS development

Why developing the Slovenia WEIS ?

Before the Project, a holistic picture of the wood energy sector was not available. The existing information relevant to this topic, sometimes very interesting and accurate, was fragmented and failed to provide a coherent appreciation of the relevance of this sector in both forestry and energy contexts. Moreover, this prevented the valuation of wood energy's economic weight as a substitute to imported fuels, as an income generator in rural areas, and its environmental role as renewable fuel.

SWEIS was therefore needed in order to interconnect this mass of fragmented elements into a simple, comprehensive frame through which the wood energy sector may be analyzed and its multiple qualities and values perceived.

Filling-in the various SWEIS elements required some estimation processes based on existing data sources. Some are the results, aggregated at national level, of the WISDOM analysis and others are based on previous studies or statistics from the Slovenia Yearbook.

The following sections list the elements of SWEIS and describe the input data used. For the WISDOM-derived items reference is made to the previous Chapter while for the other elements a short description is given.

4.1 Production

Fuelwood

From forests

Current and potential fuelwood from forests was based on the rich forest compartments database maintained by SFS [11]. National values are the summary of KO-level data reported in the WISDOM geodatabase.

From other land uses

The estimation of woody biomass from non-forest land uses was the result of a specifically designed survey which produced the first assessment ever done in the country. National values are the summary of KO-level data reported in the WISDOM geodatabase.

From industries

The amount of industrial wood residues was based on the studies done by SFI on the potential of woody biomass in Slovenia [5] [6] [10]. The best estimates of wood residue production referred to year 1995 for which a total amount of 722 000 m^3 was estimated [10]. To estimate the production of wood residues up to year 2002 a relation was assumed between the production of residues and the total amount of industrial wood products, which are reported in the Slovenia Yearbook. The latter reported a steady annual decrease in the industrial wood production of some 3.7% and, accordingly, the 1995 production was reduced annually with the same rate.

Charcoal

The production of charcoal was rather limited and concentrated in the municipality of Litija in central Slovenia, as shown in Figure 18. Time series of charcoal production, import and total consumption provided by Mr. Prah, SFS, are summarized in Table 7.

Table 8: Charcoal statistics. Values in tons

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Production	200	200	210	230	240	270	250	320	260
Import	360	350	340	320	310	280	290	300	240
Export	0	0	0	0	0	0	0	0	0
Consumption	560	550	550	550	550	550	540	620	500

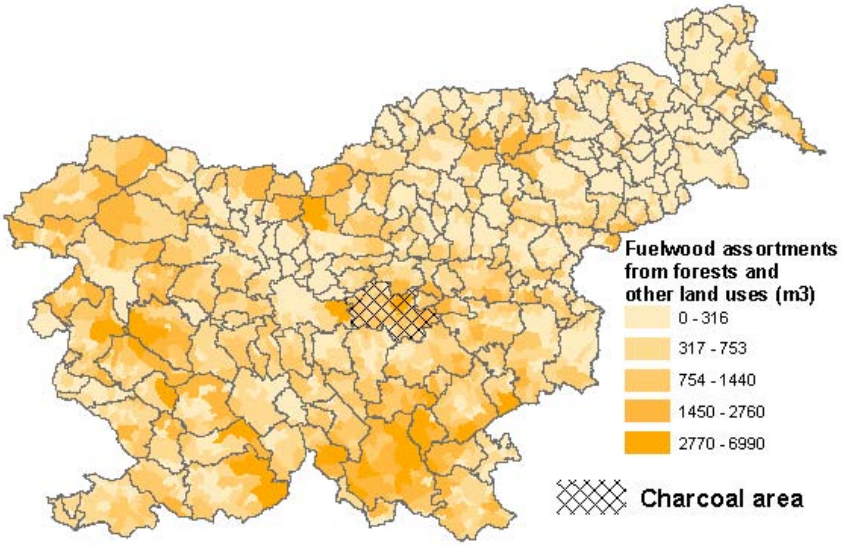


Figure 22: Charcoal production area in Slovenia: Litija Obcina. On background, distribution of the estimated current production of fuelwood assortments from forests and other land uses.

Black Liquor

Black liquor data was provided by the pulp and paper industry of Krsko, which is the only one operating in Slovenia. The annual production of black liquor corresponds to some 109 000 m^3 of wood. The data source estimated that there was little variation in this value in the last decade; accordingly, the value in SWEIS was kept constant.

4.2 Import

Fuelwood

Import of fuelwood was reported by the Slovenia Statistical Office [14]. Import of this item was minimal, ranging in the last few years around 1000 m^3.

Charcoal

See table 8 above.

Black Liquor

No import of black liquor was reported.

4.3 Export

Fuelwood

Export of fuelwood was reported by the Slovenia Statistical Office [14]. The amount annually exported is in the range of 60 000 m^3. Main fuelwood exports are to Italy.

Charcoal

No export of charcoal was reported.

Black Liquor

No export of black liquor was reported.

4.4 Consumption

Household Sector

Fuelwood

The estimation of fuelwood consumption in the household sector was a specific output of the WISDOM analysis, which was based on 2002 census of population, households, dwellings and buildings and other supporting references [8] [9] [13].

Charcoal

See table 8 above.

Black Liquor

No black liquor consumption was reported in the household sector.

Other Sectors (industrial, public, etc.)

Fuelwood

The amount of industrial wood residues consumed for non-household uses was based on the studies done by SFI [5] [6] [10]. The best estimation of the consumption of wood residues referred to year 1997 for which a total amount of 432 000 m^3 was estimated [10]. More recent data was available for DHSs, CHPs and other boilers that provide heat and steam for industrial processes, many of which are located in the same wood industries that produce the residues. The recorded consumption of available references totaled some 391 000 m^3 for year 2002. Unfortunately the available data set was not complete. In order to account, tentatively, for the missing data the consumption was estimated at some 500 000 m^3 at year 2002[12].

Charcoal

No charcoal consumption in the industrial sector was reported.

Black Liquor

The entire consumption of black liquor takes place in the pulp and paper industry of Krsko that produces it.

[12] Additional information on wood waste was generated by SFI after the completion of the WISDOM component of the Project (see Chapter “Project follow-up – WISDOM development”). However, since the response to the questionnaires sent out was not complete at the time of writing the estimated values were not replaced. Preliminary results seem to confirm the order of magnitude of the estimates used.

5 Project follow-up

Based on contributions from

Živan Veselič, Jurij Begus and Andrej Grum, Slovenia Forest Service, and

Nike Krajnc, Slovenia Forestry Institute

5.1 The impact of WISDOM on policy formulations

Local level

The WISDOM analysis has already proved its usefulness in supporting local planning, a function that the geodatabase can provide thanks to its fine geographic resolution.

A concrete case was that of five municipalities that intend to explore the possibility of developing their bioenergy potential, including the conversion of pre-existing structures (i.e. abandoned mines) to the storage of wood chips and to the production of wood pellets for the market and for local district heating stations.

The area concerned is located some 30 km Northwest of Ljubljana (Figure 19) and includes the Municipalities of Gorenja vas-Poljane, Žiri, Dobrova-Polhov Gradec, Škofja Loka and part of Logatec.

The SFS was approached by these communities with specific questions on the potential sustainable production capacity of woody biomass within their territory, the current use, the additional amounts available and other critical questions regarding the feasibility of their project.

Using the WISDOM geodatabase and integrating it with specific aspects of local relevance, the SFS could provide, without delay, a comprehensive and detailed report enriched by many tables and 15 thematic maps [16]. The aspects covered in the report included forestry data on wood assortments; their distribution and physical accessibility; productivity in non-forest areas; and analysis of wood consumption for heating in households by KO and municipality. SFS also prepared a questionnaire to be filled in by all local wood processing plants for the acquisition of reliable data on the availability and current use of wood residues.

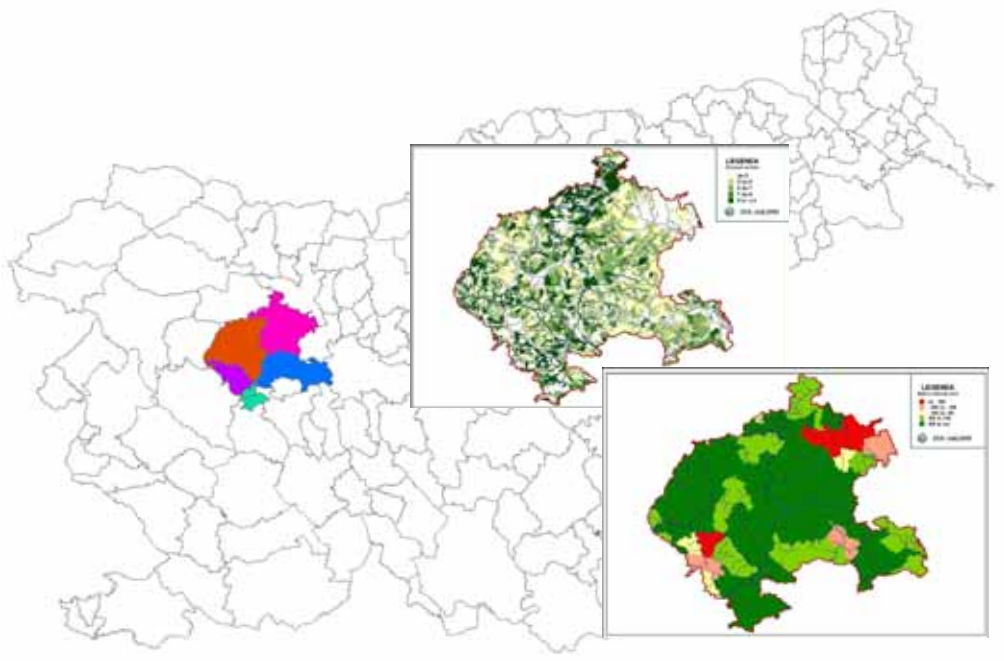


Figure 23: Location of Municipalities for which a detailed analysis of woody biomass availability for bioenergy development was carried out. The two inserted maps exemplify two of the many thematic layers produced: mean annual wood increment/hectare (top map) and balance between the quantities of available wood according to allowable cut and wood consumption in (bottom map).

National level

The knowledge generated by the Project has greatly enhanced the capacity of the Slovenia Forestry Service to cope with wood energy issues and, ultimately, to contribute to the formulation of policies and to the planning of field activities.

At present, the proposed Wood Energy Strategy, based on SWEIS and WISDOM data, represents the main reference for the inclusion of wood energy components in the National Forestry Program and for the National Program for Rural Development, both under preparation.

Field activities are now oriented to the promotion of woody biomass harvesting in private forests. These include the promotion of forest owners associations, extension, training of forest owners and SFS Staff on new technologies and other specific wood energy aspects.

Preparation of a new Slovenian Wood Biomass internet portal

In response to the growing interest on bioenergy in the country, the Slovenia Forestry Institute is currently working on a thematic internet portal that provides easy access to state-of-the-art information on all aspects of woody biomass.

The WISDOM geodatabase will be the source of a very important feature of this new internet portal, which will be dedicated to the presentation of the best statistical and cartographic data available for the 149 municipalities of Slovenia. Users will be able to check data on wood biomass potentials (supply side) and present use (demand side) at the level of local municipality (občina level). The aggregation of the original KO data (2696 units) at municipality level (192 units) was carried out by SFS.

A special section of the portal will be dedicated to the ranking of local communities according to suitability for wood energy development under different management perspectives. The priorities for the forest manager, for the local administrator or for the energy planner are not necessarily the same. The portal allows for combining the rich data set in different ways will adequately represent the cross-sectoral character of wood energy and will promote the dialogue among stakeholders.

The target groups for this internet portal are local communities, rural development agencies, forestry and energy agencies, private sector and the state.

Regional/international level

Most of the problems and opportunities that the wood energy sector presents in Slovenia are common to the countries of East and Central Europe. Actions oriented to the development of this sector are clearly needed in all these countries and the lessons learned in Slovenia may represent a useful and potentially replicable experience.

In order to promote a regionally coordinated action, the Forestry Department of FAO organized the first working meeting on “Supporting Wood Energy Planning in Eastern Europe”, at FAO headquarters in Rome on 16 March 2005, as a side event of the 2005 FAO Committee on Forestry (COFO), attended by representatives of 13 countries and 3 international organizations. The meeting presented the main findings and results of the FAO project “Supply and Utilization of Bioenergy to Promote Sustainable Forest Management (TCP/SVN/2901)” in Slovenia and examined possible dissemination of knowledge, based on that project, to other Central and Eastern European countries (CEEC). The meeting also discussed a project proposal aimed at enhancing the capacity of Forestry Services of CEEC to plan sustainable utilization of forest biomass for energy and identified follow up actions.

The second working session was hosted by the Slovenia Ministry of Agriculture, Forestry and Food (MAFF) in collaboration with FAO, and organized by the Slovenia Forest Service. The international workshop, under the title “Development of Woody Biomass for Energy in Central and Eastern European Countries” was held from 9 to 11 November 2005 in Bled, Slovenia.

Delegates from 12 countries participated to the three-days meeting: Estonia, Czech Republic, Romania, Bulgaria, Macedonia, Serbia, Croatia, Hungary, Sweden, Italy, Latvia and Slovenia.

The participants agreed on the need for a coordinated action and further refined the elements of a proposed regional program to be submitted to potential donors for financial and institutional support.

5.2 WISDOM development

A study on current availability and use of wood residues from wood processing industries was carried out at the end of 2004 by the Slovenian Forestry Institute to complete and consolidate the information about this important aspect of the Slovenia wood energy sector. In fact, industrial wood residues are important source of woody biomass for larger biomass systems, along with forest harvesting residues.

The results were processed by municipality (občina) and subsequently handed over to SFS for insertion into the WISDOM geodatabase.

To estimate the potential of wood residues in Slovenia SFI carried out a questionnaire survey among wood processing industry in Slovenia. The questionnaire was send to all 2335 companies which were registered for wood processing activities in summer 2004. By end 2004 valid answers were received from 326 companies.

The annual amount of wood processed in these 326 companies was around 1.300.000 m^3 and the annual amount of wood residues produced in these companies was over 250 000 t.

According to this preliminary set of questionnaires, it appeared that the majority of wood residues, i.e. 39%, were classified as clean (uncontaminated) wood, 31% as sown dust, 11% as sown powder and 5% as contaminated wood wastes. It is important to note that these industries are already using almost half of all wood residues to cover their own need for energy (Figure 20).

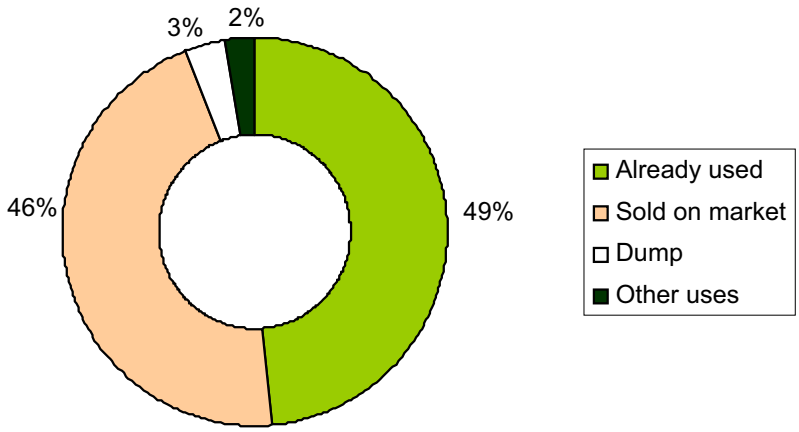


Figure 24: Present use of wood residues (N=326 answers)

5.3 Further recommended action

In order to maintain long-term effectiveness of WISDOM and SWEIS as planning tools, it is recommended that data collection be continued and further developed by Slovenia. Future data collection should include the following information:

- fuelwood consumption time series for the household sector, or related indicators; this information will allow for the assessment of consumption trends and the elaboration of possible short-term development scenarios;
- complete data on the production of wood residues by forest industries and on woodfuel consumption and energy production by biomass plants.
- accessibility factors that limit the full exploitation of the country's wood energy potential from a physical, legal and economic perspective[13].

As mentioned before, the official national statistics on woodfuels are incomplete and do not reflect the true role that wood energy plays in both forestry and energy sectors. This is a major limitation in the development of this sector. It is therefore strongly recommended that the Statistical Office of Slovenia define, in collaboration with forestry and energy authorities, a set of wood energy variables and that specific attention be given to the production and consumption of individual woodfuels in future statistical surveys of both forestry and energy sectors.

[13] Elements of physical accessibility, linked to skid tracts, distance from roads and slope, were already included in the WISDOM geodatabase (analysis of physical accessibility done by Živan Veselič and Rok Pisek)

References

[1] Chalico T.A., E. Riegelhaupt, 2002. A guide for woodfuel surveys. FAO. Available at : http://www.fao.org/DOCREP/005/Y3779E/Y3779E00.HTM

[2] Data from Register of Slovenia, Chamber of Commerce and from Ministry of Environment and Spatial Planning.

[3] FAO 2004. UBET Unified Bio Energy Terminology. Available at http://www.fao.org/DOCREP/007/j4504E/j4504E00.HTM

[4] Hocevar, Milan, 2004. Slovenia Forestry Institute. Preliminary results of the study on Slovenia forest area change 1975-2000. Personal communication

[5] Krajnc, Nike, 2002. Biomass developments and research in Slovenia. Slovenia Forestry Institute.

[6] Krajnc, N., P. Simončič and R. Robek, 2002.Slovenian forests and their role in meeting Kyoto requirements.

[7] Masera, O.R., R. Drigo, M. A. Trossero, 2003. Woodfuels Integrated Supply/Demand Overview Mapping – WISDOM. FAO. http://www.fao.org/DOCREP/005/Y4719E/Y4719E00.HTM.

[8] Ministry of Energy. Study for energy plan and 2030 projections.

[9] Ministry of Environment, 2002. Estimation of potential emission reduction in Slovenia. Final report.

[10] Robek, R., M. Mevdev, L. Zgajnr, N. Pogacnik, B. Bitenc, 1998. Removing barriers to biomass district heating projects in Slovenia. Analysis of wood biomass potential in Slovenia. SFI

[11] Slovenia Forest Service, various sources and personal communications.

[12] Slovenia Forestry Institute, various sources and personal communications.

[13] Statistical Office of the Republic of Slovenia. Census of population, households, dwellings and buildings 2002.

[14] Statistical Yearbook of the Republic of Slovenia 2003 - Forestry and hunting. (Reference of FAOSTAT Forestry Statistics for Slovenia); Industrial Products.

[15] Drigo, R. 2005. i-WESTAT. Update and upgrade of the interactive Wood Energy Statistics. FAO Wood Energy Programme.

[16] Ogrizek, R., Pisek, R., Veselič, Ž., 2005. Ocena potencialov lesne biomase. Zaključno poročilo. ZGS.

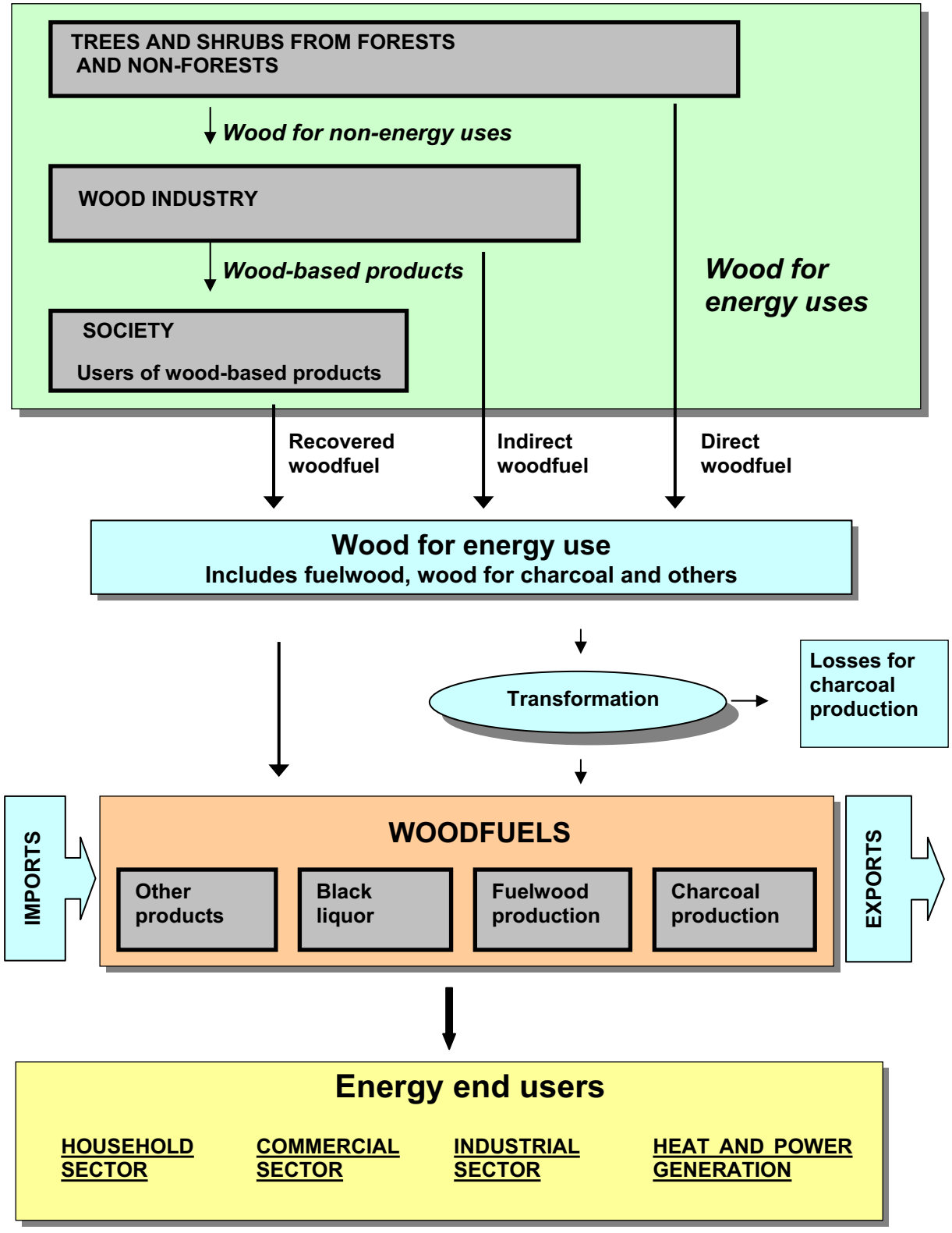
Documents of Project “Supply and Utilization of Bioenergy to Promote Sustainable Forest Management”

TCP/SVN/2901

- WISDOM Slovenia. Annex 6 Final Report by Rudi Drigo, FAO, and Živan Veselič, Slovenia Forest Service.
- Charcoal Use and Trade in Slovenia. Annex 9 – 7b Final Report by Jože Prah, Slovenia Forest Service..
- Education, Training and Demonstration. Annex 8 Final report by Nike Krajnc, Slovenia Forestry Institute.
- State of the art of wood biomass preparation and use in Slovenia. Annex 9 Final Report by Slovenia Forestry Institute.

Annexes

Annex 1.
Unified Wood Energy Terminology – Conceptual view



Annex 2. Summary of statistical data received from Statistical Office of Slovenia

Variables	Adminis-trative Units (67)	Munici-palities (192)	Cadastral commu-nities (KO) (2696)	Settle-ments (5974)
Urban population				X
Rural population				X
Total Population			X	
No. of dwellings by size classes	X	X	X	
No. of dwellings (and people) using exclusively wood for heating	X	X	X	
No. of dwellings (and people) using wood as primary fuel for heating	X	X	X	
No. of dwellings (and people) using wood as secondary fuel for heating	X	X		
No. of dwellings by heating system (district heating; boiler for several buildings; central [building]; central [apartment]; stoves; no heating system]	X	X		
Dataset to be used to build the profile of fuelwood users: Limited to the subset that uses exclusively or primarily wood for heating				
No. of dwellings by type of housing (one-dwelling house; apartment; other)	X	X		
No. of dwellings by ownership (private property; property of state or public entities; other)	X	X		
No. of dwellings by number of persons (1; 2; 3-5; >5) and No. of households in dwellings	X	X		
No. of dwellings by use of the dwelling (residence; res.& business; business; temporary and permanently unoccupied; leisure; seasonal)	X	X		
No. of dwellings by size classes (<50 m^2; 50-80; 81-110; >110)	X	X		
No. of dwellings with central heating	X	X		
No. of dwellings by type of heating system (central [building]; central [apartment]; stoves]	X	X		
Secondary fuel used for heating - after wood - (coal; fuel oil; electricity; nat. gas; lpg; other)	X	X		
Household reference persons by tenure (owner; tenant; other)	X	X		
Household reference persons by level of education	X	X		
Household reference persons by activity status (employed; self-employed; farmer; unemployed; pensioner; other)	X	X		
Household reference persons by means of transport to work (foot or cycle; bus or train; other)	X	X		

Data on agricultural holdings (census 2000)				
No. of farm holdings and household members	X	X		
Area under agric. holding (total land, utilized agric., abandoned, other non cultivated, forests, barren land)	X	X		
Supplementary activities in agr. (wood processing, tourism, cottage industry, forestry services, sale of wood products	X			
Broadleaves and coniferous wood products (logs, poles, pulpwood and boardwood, fuelwood)	X			
Fuelwood produced by holdings with forest	X	X		
Fuelwood produced by holdings without forest	X	X		

Effect of Confidentiality Policy:

The confidentiality policy, which imposes to hide records with very small numbers (for which individual entities –persons, firms, etc.- may be identified) had considerable effect on data at KO level and for some variables even at municipality level. In fact, in order to hide one KO within a municipality and to prevent the deduction of its values, a second KO within the same municipality, selected at random, is hidden.

Annex 3. Household fuelwood consumption estimates

Energy requirements for house heating only						
	Construction year	Requirements by type[1] kWh/m2	# of dwellings	Group average kWh/m2	Group average kWh/m2	Total average kWh/m2
single family houses	before 1980	185	13203			
		144	1467			
		163	6449	175.8		
		111	0			
		210	1317		**169.3**	
		151	1518			
	after 1980	111	375			
		111	1820			143.4
		90	337			
apartments in blocks	before 1980	125	11720			
		98	1302			
		90	4565		109.7	
		84	2533			
		75	281			

[1] Depending on levels of insulation and maintenance.

Ref: Estimation of potential emission reduction in Slovenia. Final report. Ministry of Environment. 2002

Estimated additional requirements for cooking and water heating	**31%** of house heating

Ref: Ministry of Energy. Study for energy plan and 2030 projection.

Fraction of occupied dwellings primarily using wood	**0.814**
Fraction of 'large dwellings' area (> 80 m2) among primary wood users	**0.59**

Ref: [13] Census 2002 (file:Gozd_institut_t4_OB.xls)

Non-heated fraction of large dwellings	**0.3**

Reporting Consultant's estimate

Dwellings using wood (primarily) – Census 2002	
Total m^2	**17,335,126**
Estimated occupied and heated	
# 0f dwellings	**234,898**
Occupied dwellings	**191,312**
people in dw	**594,934**

Main conversion factors

1 kWh =	3600000	joules	=	3.6	MJ	
1 MJ =	0.277778	kWh				
1 CUM wood =	2900	kWh	=	10440	MJ	0.00 assumed efficiency loss
1 CUM wood =	0.725	tons	(average for *fagus* 20%humidity in Germany- average FAO)			
1 CUM wood =	1.54	m3 stack wood				
1 kg wood =	3.366	kWh				
1 kg wood =	14.4	MJ	=	4.0000032	kWh	

Energy requirements [1]			**0.85** efficiency			**0.65** efficiency		
			2465 =kWh/CUM			1885 =kWh/CUM		
	kWh/m^2	**MJ/m^2**	**CUM/m^2**	**tons/m^2**	**Stackwood/m^2**	**CUM/m^2**	**tons/m^2**	**Stackwood/m^2**
house heating	160	576	0.0649	0.0471	0.0999	0.08488	0.0615	0.1306
total heat & cooking	208	748.8	0.0844	0.0612	0.1298	0.11034	0.0800	0.1698
Total Slovenia	**kWh**	**TJ**	**CUM**	**tons**	**m3 stackwood**	**CUM**	**tons**	**m3 stackwood**
house heating	1,858,926,454	6,692	754,128	546,743	1,160,197	986,167	714,971	1,517,180
total heat & cooking	2,416,604,390	8,700	980,366	710,765	1,508,256	1,282,017	929,462	1,972,334
by dwelling (wf users)	**kWh/dw**	**MJ/dw**	**CUM/dw**	**tons/dw**	**Stackwood/dw**	**CUM/dw**	**tons/dw**	**Stackwood/dw**
house heating	9,717	34,980	3.9	2.86	6.1	5.2	3.74	7.9
total heat. & cooking	12,632	45,474	5.1	3.72	7.9	6.7	4.86	10.3
by inhabitant (wf users)	**kWh/inh**	**MJ/inh**	**CUM/inh**	**tons/inh**	**Stackwood/inh**	**CUM/inh**	**tons/inh**	**Stackwood/inh**
house heating	3,125	11,249	1.3	0.92	2.0	1.7	1.20	2.6
total heat. & cooking	4,062	14,623	1.6	1.19	2.5	2.2	1.56	3.3

[1] The estimated energy requirement for heating only used, as main reference, the weighted average for single-family houses (see previous page). The total energy requirement for heating and cooking was estimated by adding 30 % to the amount required for heating only.

Annex 4. WISDOM parameters by category

Attribute table of geodatabase KOWISDOM with national summary values. Values associated to Kadastral Obcina (KO) polygons (2697 records)

Spatial / administrative parameters

Field name	Description	unit	totals
SIFKO	Code of Kadastral Obcina (KO), numeric		
KO	Code of Kadastral Obcina (KO), text		
IMEKO	Name of KO		
MAINOB_COD	Code of main municipality (Obcina=OB) where the larger portion of KO is situated		
MAINOB_NAM	Name of main municipality (Obcina=OB) where larger portion of KO lies.		
AREA_HA	Total area of KO in ha (from digital map)	ha	**2,028,533**
OKRAJ_SIF	Code of OKRAJ administrative unit		
OKRAJ_IME	Name of OKRAJ administrative unit		
GGO	Regional code		

Demand-related parameters

Household

TOT_POP	Total population of KO		**1,963,341**
URB_POP	Fraction of urban population (as defined in settlement database)		
RUR_POP	Fraction of rural population (as defined in settlement database)		
INH_PRWF	Number of inhabitants using fuelwood as exclusive or primary fuel for heating		**592,418**
SATURATION	INH_PRWF / TOT_POP (fraction of population using wood for heating)		
TOT_DW_PRWF	Number of dwellings using fuelwood as exclusive or primary fuel for heating		**233,909**
GRS_M2_PRWF	Total surface (m2) of dwellings using fuelwood as exclusive or primary fuel for heating (occupied and non)	m^2	**17,256,817**
M3_CONS_HC	Gross volume of wood needed for house heating (77%) plus water heating and cooking (23%), (occupied and non)	m^3	**1,904,199**
M3_CONS_C	Gross volume of wood needed for water heating and cooking (occupied and non)	m^3	**439,431**
M3_CONS_H	Gross volume of wood needed for house heating only (occupied and non)	m^3	**1,464,768**
OCCU_DW_PRWF	Number of occupied dwellings using fuelwood as exclusive or primary fuel for heating		**190,517**
OCCU_M2_PRWF	Total surface (m2) of occupied dwellings using fuelwood as exclusive or primary fuel for heating	m^2	**14,107,542**
HEATED_M2	Estimated heated surface (m2) of occupied dwellings using fuelwood as exclusive or primary fuel for heating	m^2	**11,598,427**
NETM3_CONS_H	Net volume of wood needed for house heating (77%) (heated surface of occupied dwellings)	m^3	**984,481**
NETM3_CONS_C	Net volume of wood needed for water heating and cooking (23%) (occupied dwellings)	m^3	**295,344**
NETM3_CON_HC	Net volume of wood needed for house heating (77%) plus water heating and cooking (23%) (heated surface of occupied dwellings)	m^3	**1,279,825**

Supply-related parameters

1 – Area and ownership (forestry data)

Field name	Description	unit	totals
TOTFORAREA	Total forest area from SFS database	ha	**1,185,306**
EXPLAREA	Exploitable forest area (categories 1 and 2 only). All other forest variables relate to this area.	ha	**1,104,794**
OWNERS	Number of forest owners (sum of owners from compartments database. Owners of forest plots in different compartments are double counted). Indicative only. Total count is approx. double of actual number		**620,809**
OW2_FRACT	Fraction of forest ownership 2: PRIVATE		
OW3_FRACT	Fraction of forest ownership 3: Other Officials (mainly religious institutions)		
OW5_FRACT	Fraction of forest ownership 5: STATE		
OW6_FRACT	Fraction of forest ownership 6: CIVIL (rural) COMMUNITIES		
OW236_FRAC	Fraction of NON-State forest ownerships (2, 3 and 6)		
OW2	Area of forest ownership 2: PRIVATE	ha	**801,325**
OW3	Area of forest ownership 3: Other Officials (mainly religious institutions)	ha	**10,202**
OW5	Area of forest ownership 5: STATE	ha	**281,107**
OW6	Area of forest ownership 6: CIVIL (rural) COMMUNITIES	ha	**12,102**
PH1AR	Area under Phase Development 1: Seedlings	ha	**81,030**
PH2AR	Area under Phase Development 2: Early pole stage	ha	**87,427**
PH3AR	Area under Phase Development 3: Late pole stage	ha	**332,462**
PH4AR	Area under Phase Development 4: Timber tree	ha	**367,812**
PH5AR	Area under Phase Development 5: Regeneration forest	ha	**80,349**
PH6AR	Area under Phase Development 6: Selection forest	ha	**10,831**
PH7AR	Area under Phase Development 7: Coppices	ha	**43,384**
PH8AR	Area under Phase Development 8: Former Coppices (under conversion to high forest)	ha	**19,639**
PH9AR	Area under Phase Development 9: Litter forest	ha	**17,727**
PH10AR	Area under Phase Development 10: Bush forest	ha	**22,252**
CL1	Accessibility class 1 = slope <30% dist. < 400 m (% of EXPLAREA)		
CL2	Accessibility class 2 = slope <30% dist 400-800 m (% of EXPLAREA)		
CL3	Accessibility class 3 = slope <30% dist. > 800 m (% of EXPLAREA)		
CL4	Accessibility class 4 = slope >30% dist. <400 m (% of EXPLAREA)		
CL5	Accessibility class 5 = slope >30% dist 400-800 m (% of EXPLAREA)		
CL6	Accessibility class 6 = slope >30% dist. > 800 m (% of EXPLAREA)		

Supply-related parameters

2 – Area (land use data)

Field name	Description	unit	totals
TOT_LU_HA	Total area from Land Use map	ha	**2,027,050**
NonFor_Area	Total area from Land Use map - forest area (LU_2000)	ha	**825,565**
LU_1100	Land Use class 1100 Fields and gardens	ha	**213,985**
LU_1160	Land Use class1160 Hops fields	ha	**2,501**
LU_1211	Land Use class1211 Vineyard	ha	**25,303**
LU_1221	Land Use class1221 Intensive orchard	ha	**5,049**
LU_1222	Land Use class1222 Extensive orchard	ha	**19,849**
LU_1230	Land Use class1230 Olive trees orchard	ha	**1,139**
LU_1240	Land Use class1240 Other agr. plantations	ha	**43**
LU_1310	Land Use class1310 Intensive meadow	ha	**159,652**
LU_1321	Land Use class1321 Swamp meadow	ha	**3,084**
LU_1322	Land Use class1322 Extensive meadow	ha	**187,930**

LU_1410	Land Use class1410 re-growth on old farmland	ha	**25,246**
LU_1420	Land Use class1420 Forest plantation	ha	**586**
LU_1500	Land Use class 1500 Mixed use (agric. and forestry)	ha	**18,953**
LU_2000	Land Use class 2000 Forest and other wooded land	ha	**1,201,485**
LU_3000	Land Use class 3000 Urban and built up areas, roads	ha	**108,194**
LU_4100	Land Use class 4100 Swamp	ha	**188**
LU_4210	Land Use class 4210 Reeds	ha	**1,084**
LU_4220	Land Use class 4220 Other water logged areas	ha	**1,472**
LU_5000	Land Use class 5000 Dry areas with grass	ha	**9,217**
LU_6000	Land Use class 6000 Barren land without grasses	ha	**28,777**
LU_7000	Land Use class 7000 Water bodies	ha	**13,314**

Supply-related parameters

3 – Volume data

STOCKTOT	Total forest stocking of all diameter classes > 10 cm DBH	m^3	**261,982,273**
INCRTOT	Total annual increment of all diameter classes > 10 cm DBH	m^3	**6,863,027**
TOT_WOOD_G	Annual allowable cut of all timber and non-timber assortments	m^3	**3,926,823**
PREF_FW_G	Annual allow. cut of non-timber assortments of fuelwood species commonly used (group BCD; see Annex 5)	m^3	**1,407,272**
TOT_O_FW_G	Annual allowable cut of non-timber assortments of all species (all conifers included)	m^3	**2,147,768**
CONIF_O	Annual allowable cut of non-timber assortments of Coniferous species (Larix excluded)	m^3	**689,556**
LARIX_O	Annual allowable cut of non-timber assortments of *larix decidua*	m^3	**16,379**
HARDBR_O	Annual allowable cut of non-timber assortments of quality hard Broadleaved species	m^3	**1,164,850**
FWSPECIES	Annual allowable cut of Fuelwood assortments (selected hard Broadleaved species)	m^3	**226,043**
SOFTBR_O	Annual allowable cut of non-timber assortments of soft Broadleaved species	m^3	**50,940**
CUT_WOOD_G	Annual actual cut of all timber and non-timber assortments	m^3	**2,366,222**
CUT_P_FW_G	Annual actual cut of non-timber assortments of fuelwood species commonly used (group BCD; see Annex 5)	m^3	**839,700**
CUT_T_FW_G	Annual actual cut of non-timber assortments of all species (all conifers included)	m^3	**1,283,494**
CUT_CONI_O	Annual actual cut of non-timber assortments of Coniferous species (Larix excluded)	m^3	**413,495**
CUT_LAR_O	Annual actual cut of non-timber assortments of *larix decidua*	m^3	**9,958**
CUT_H_BR_O	Annual actual cut of non-timber assortments of quality hard Broadleaved species	m^3	**697,242**
CUT_FWSPP	Annual actual cut of Fuelwood assortments (selected hard Broadleaved species)	m^3	**132,499**
CUT_S_BR_O	Annual actual cut of non-timber assortments of soft Broadleaved species	m^3	**30,299**
NonFor_Stock	Stocking of non-forest land use classes	m^3	**11,436,452**
NonFor_MAI	Mean annual increment of non-forest land use classes	m^3	**394,402**
NFor_Prod	Estimated sustainable productivity in non-forest land use classes (MAI* 0.7)	m^3	**276,081**
CutPfw_NFP	Sum of actual cut of preferred FW species + non-forest productivity	m^3	**1,115,781**

Integration parameters

Production / consumption balances

Field name	Description	unit	totals
BGFWSP_H	Balance of gross allowable volume of fuelwood assortments: FWspecies <minus> NETM3_CONS_H	m^3	**-758,438**
BGP_FW_H	Balance of gross allowable volume of preferred non-timber assortments: Pref_FW_g <minus> NETM3_CONS_H	m^3	**422,791**
BGO_FW_H	Balance of gross allowable volume of all non-timber assortments: Tot_O_FW_g <minus> NETM3_CONS_H	m^3	**1,163,287**
BCUTFWSPH	Balance of gross actual cut of fuelwood assortments: FWspecies <minus> NETM3_CONS_H	m^3	**-851,982**
BCUTP_FWH	Balance of gross actual cut of preferred non-timber assortments: Pref_FW_g <minus> NETM3_CONS_H	m^3	**-144,781**
BCUTO_FWH	Balance of gross actual cut of all non-timber assortments: Tot_O_FW_g <minus> NETM3_CONS_H	m^3	**299,013**
BGFWSP_HC	Balance of gross allowable volume of fuelwood assortments: FWspecies <minus> NETM3_CONS_HC	m^3	**-1,053,782**
BGP_FW_HC	Balance of gross allowable volume of preferred non-timber assortments: Pref_FW_g <minus> NETM3_CONS_HC	m^3	**127,447**
BGO_FW_HC	Balance of gross allowable volume of all non-timber assortments: Tot_O_FW_g <minus> NETM3_CONS_HC	m^3	**867,943**
BCUTFWSPHC	Balance of gross actual cut of fuelwood assortments: FWspecies <minus> NETM3_CONS_HC	m^3	**-1,147,326**
BCUTP_FWHC	Balance of gross actual cut of preferred non-timber assortments: Pref_FW_g <minus> NETM3_CONS_HC	m^3	**-440,126**
BCUTO_FWHC	Balance of gross actual cut of all non-timber assortments: Tot_O_FW_g <minus> NETM3_CONS_HC	m^3	**3,669**
BGP_NFP_HC	Balance of gross allowable volume of preferred non-timber assortments +nonforest productivity: Pref_FW_g +NFor_Prod <minus> NETM3_CONS_HC	m^3	**403,528**
BGO_NFP_HC	Balance of gross allowable volume of all non-timber assortments +nonforest productivity: TOT_O_FW_G +NFor_Prod <minus> NETM3_CONS_HC	m^3	**1,144,024**
BCP_NFP_HC	Balance of gross actual cut of preferred non-timber assortments +nonforest productivity: CUT_P_FW_G +NFor_Prod <minus> NETM3_CONS_HC	m^3	**-164,044**
BCO_NFP_HC	Balance of gross actual cut of all non-timber assortments +nonforest productivity: CUT_T_FW_G +NFor_Prod <minus> NETM3_CONS_HC	m^3	**279,750**

Values associated to settlements point data (5997 records)

Spatial / administrative parameters

Field name	Description	unit	totals
SO_CODE	Settlement code as per Statistical Office (old obcina code + settlement code)		
MAP_CODE	Settlement code (new obcina code + settlement code)		
SO_NAME	Settlement name (from Statistical Office)		
OB_ID	Obcina code		
OB_IME	Obcina name		
NA_ID	Settlement code within Obcina from Map		
NA_IME	Settlement name (from settlement map)		
Y_C	Y point coordinate		
X_C	X point coordinate		

Demand-related parameters

Household

SETTLCODE	1= Urban ; 2= Rural		
POP	Population		**1,962,479**

Demand-related parameters

Biomass plants

BmSyst_Loc	Location name of biomass systems		
Numb_sites	Number of separate biomass systems		**65**
BioSys_dat	Biomass system information (Y/N) = 31 Y and 34 N		
w_cons_t	Wood consumption in tons (incomplete data)	t	**283,547**
w_cons_m3	Wood consumption in cubic meters (incomplete data)	m^3	**391,102**
Cap_h_MW	Power capacity of biomass system (incomplete data)		
Syst_type	Type of system (CHP, DHS, n.a.) (incomplete data)		

Supply-related parameters

Wood industries

Wood industries			
P20	Number of employees in primary wood processing industries (approximate)		
S36	Number of employees in secondary wood processing industries (approximate)		

Annex 5. SFS databases

Fields of the database **FOND1x.dbf**, which summarizes forest compartments' information (approx. 65000 records) at KO level (2697 records)

KO	Cadastral Community	
TOTAREA	Total forest area	
EXPLAREA	Exploitable area (legal factors) include only categories 1 and 2	
ACCESS_1	slope <30% dist. < 400 m	
ACCESS_2	slope <30% dist 400-800 m	
ACCESS_3	slope <30% dist. > 800 m	
ACCESS_4	slope >30% dist. <400 m	
ACCESS_5	slope >30% dist 400-800 m	
ACCESS_6	slope >30% dist. > 800 m	
OW2	private property	
OW3	property of other officials (mainly religious institutions)	
OW5	state property	
OW6	property of civil (rural) community	
ASOC1	Code of association 1 (see list of species associations)	
ASOC1AR	area of association 1	
ASOC2	=	
ASOC2AR	=	
ASOC3	=	
ASOC3AR	=	
ASOC4	=	
ASOC4AR	=	
ASOC5	=	
ASOC5AR	=	
ASOC6	=	
ASOC6AR	=	
ASOC7	=	
ASOC7AR	=	
ASOC8	=	
ASOC8AR	=	
ASOC9	=	
ASOC9AR	=	
STOCK1	Stocking of diameter class 1	10-30
STOCK2	Stocking of diameter class 2	30-50
STOCK3	Stocking of diameter class 3	> 50
STOCKTOT	Total stocking	
INCR1	Increment of diameter class 1	10-30
INCR2	Increment of diameter class 2	30-50
INCR3	Increment of diameter class 3	> 50
INCRTOT	Total increment	
CUT	Fraction of allowable cut actually cut	
YYEAR	Year of last survey	
PH1AR	area of phase dev. 1	
PH2AR	=	
PH3AR	=	
PH4AR	=	
PH5AR	=	
PH6AR	=	
PH7AR	=	
PH8AR	=	
PH9AR	=	
PH10AR	=	

Code	phase development
01	SEEDLINGS
02	EARLY POLE STAGE
03	LATE POLE STAGE
04	TIMBER TREE
05	REGENERATION FOREST
06	SELECTION FOREST
07	COPPICE
08	FORMER COPPICE
09	LITTER FOREST
10	BUSH FOREST

SPGR_1T	Species group 1 (conifers ex. larix) timber assortments
SPGR_1O	Species group 1 (larix) other assortments (incl energy use)
SPGR_2T	Species group 2 (hard broadleaves) timber assortments
SPGR_2O	Species group 2 (hard broadleaves) other assortments (incl energy use)
SPGR_3F	Species group 3 (hard broadleaves) fuelwood use only
SPGR_4T	Species group 4 (soft broadleaves) timber assortments
SPGR_4O	Species group 4 (soft broadleaves) other assortments (incl energy use)

Fields of file **KOSORTIX.dbf**, which summarizes forest compartments' information on wood products assortments at cadastral community level according to management plans' 10-years allowable cut.

KO	Cadastral community
GRP	Species grouping under wood energy perspective (see below)
GRPTREE	Tree group code (see below)
GRPNAME	Tree group name (see below)
SORTIM	Main assortment types (see below)
GRPSORT	Assortment grouping under wood energy perspective (see below)
NETOM3	Net volume of 10-year allowable cut
BRUTOM3	Gross volume of 10-year allowable cut
PERCENT	Assortment as percent of GRPTREE total allowable cut

GRP	**GRPTREE**	**GRPNAME**
A	11	Spruce tree (Picea abies)
A	21	Fir tree (Abies alba)
A	30	Pine tree (Pinus silvestris, P. nigra)
B	34	Larch (Larix decidua)
A	39	Other Conifers
C	40	Beech tree (Fagus silvatica)
C	50	Oak tree (Quercus robur, Q.sessiliflora, Q. rubra)
C	55	Chestnut tree (Castanea sativa)
C	60	Quality broad leaved trees (Acer pseudoplatanus, Fraxinus excelsior, Tilia cordata,Ulmus sp.,Prunus avium, Juglans)
D	70	Other hard broad leaved trees (Carpinus,Ostrya,Fraxinus ornus,Robinia, Acer campestre,Sorbus, Quercus pubescens)
E	80	Other soft broad leaved trees (Betula,Salix,Laburnum alpinum)
E	90	Poplar, Black Alder (Populus sp., Alnus glutinosa)

GRPSORT	**SORTIM**
T	Log-Timber I
T	Log-Timber II
T	Log-Timber III
T	Log-Timber
O	Other Timber
O	Cellulose Timber
O	Cord Wood
F	Fuel Wood

Annex 6. Non-forest biomass survey

Slovenia is a biomass rich country, where the forest area is accompanied by other land uses that are often rich of woody biomass and by consistent areas of abandoned farmland that reverts to forest. While forests are studied in detail by forestry institutions and their production capacity is well known, little or no information was available concerning the amount of fuelwood produced outside forests and on the current and potential role of these areas in planning sustainable wood energy systems. On the other hand, it was understood that a significant part of fuelwood trade for household use is informal as fuelwood is either collected by farmers in their own lands and forests or bought locally.

To fill this information gap, and thus to complete the supply module, a specific survey of non-forest fuelwood sources was completed. The survey followed a two-phase approach based on (i) the new 2002 Land Use Map, used as stratification system (see table below), (ii) the available ortophotos coverage, used to estimate the crown cover of woody vegetation, and (iii) field sampling to relate crown cover to woody biomass stocking and increment.

Land use classes – Slovenia.

Land use classes	Total area	Minimum mapping	Relevance for woody biomass
	ha	m^2	
1 Agricultural land			
1100 Fields and gardens	**213,985**	5000	low
1160 Hops fields	**2,501**	1000	marginal
1211 Vineyard	**25,303**	500	marginal
1221 Intensive orchard	**5,049**	1000	medium
1222 Extensive orchard	**19,849**	1000	medium
1230 Olive trees orchard	**1,139**	500	medium
1240 Other agricultural. plantations	**43**	1000	marginal
1310 Intensive meadow	**159,652**	5000	medium
1321 Swamp meadow	**3,084**	5000	marginal
1322 Extensive meadow	**187,930**	5000	medium
1410 re-growth on old farmland	**25,246**	5000	high
1420 Forest plantation	**586**	5000	marginal
1500 Mixed use (agric. and forestry)	**18,953**	5000	medium
2000 Forest and other wooded land	**1,201,485**	5000	
3000 Urban and built up areas, roads	**108,194**	10	low
4 Water logged areas			
4100 Swamp	**188**	5000	
4210 Reeds	**1,084**	5000	
4220 Other water logged areas	**1,472**	5000	
5000 Dry areas with grass	**9,217**	5000	
6000 Barren land without grasses	**28,777**	5000	
7000 Water bodies	**13,314**	10	
Total area	**2,027,050**		

Land Use Map publication 2002. Approximate reference date 2000 (date of ortophotos)

Sampling scheme to assess non-forest biomass

In the first phase of the two-phase survey, a systematic sample of non-forest land units was analyzed using the digital ortophotos on which the 2002 land use map was based. The selected land units were identified on the digital ortophoto data set and interpreted to assess the average crown coverage of trees and lower woody vegetation, such as bushes and young trees.

Interpretation of cover types

The digital ortophotos offered an excellent base for the interpretation of vegetation cover and for the distinction of cover types. The national consultant and the RC defined the following cover types, in consideration of photo characteristics and of basic requirements for the subsequent field-measurement phase:

Code	Cover type
1	**Bushes and young trees (vegetation below 7 m height)**
2	**Intensive orchard**
3	**Extensive orchard**
4	**Young forest stand (up to the pole stand)**
5	**Middle-age forest stand (small to medium tree crown size)**
6	**Mature forest stand (medium to large tree crown size)**
7	**Individual (isolated) trees – crown area < 50 m^2 (diameter <8m)**
8	**Individual (isolated) trees – crown area > 50 m^2 (diameter >8m)**
9	**Lines of trees (e.g. roadside trees, hedges, etc.) with crown diameter < 8 m**
10	**Lines of trees (e.g. roadside trees, hedges, etc.) with crown diameter > 8 m**

All interpretation was carried out visually on computer monitor. Each interpretation class was digitized as a closed polygon and coded according to cover type.

Cover types 1 and 4 referred to shrubs, bushes and young trees whose average height was estimated to be below 7 m. Type 1 referred to individual plants or small groups and 4 to larger formations.

The two orchard cover types referred to systematic layouts, usually composed by smaller crowns (2) and to older, irregular formations, usually composed by larger crowns (3). These two classes were found within or outside the classes defined as “orchards” in the land use map (in urban areas, for instance).

Dense stands were separated according to the size of tree crowns, into middle-age (5) and grow-up (6). A comparison with nearby forests allowed for the separation of stands that appeared younger from stands that appeared more mature.

Individual trees were divided into two main types: small to medium trees, with crown diameter below 8 m (7) and medium to large trees, with crown diameters above 8 m (8). Similarly, trees in lines were separated according to the width of the line. Where tree rows were wider, including two or more trees, they were classified as forest stands.

Other specifications

Minimum interpretation unit

The minimum interpreted crown area was 3 x 3 m (3 x 3 mm at scale 1:1000)

Sub-sample of large polygons

In case of **large polygons** (>100 ha) the interpretation was done on a representative fraction of the entire polygon area. The polygon was intersected with a **1 ha grid** and the interpretation area was a systematic sample of the grid cells. The intensity of the systematic sample (1 on 2, 1 on 3, 1on 4, etc.) depended on the size of the polygon, with a **minimum of 20 interpreted sub units** (grid cells) well distributed over the polygon.

The class 3000 (Urban and built up, inclusive of roads) was practically one unique polygon over the entire Slovenia, since all urban centers are connected by thin stripes (roads). Therefore, **in case of class 3000**, and only in this case, the sampling unit was defined by the intersection between the class polygon and **a circle of 250 m. radius** around the selected 4x4 Km grid point.

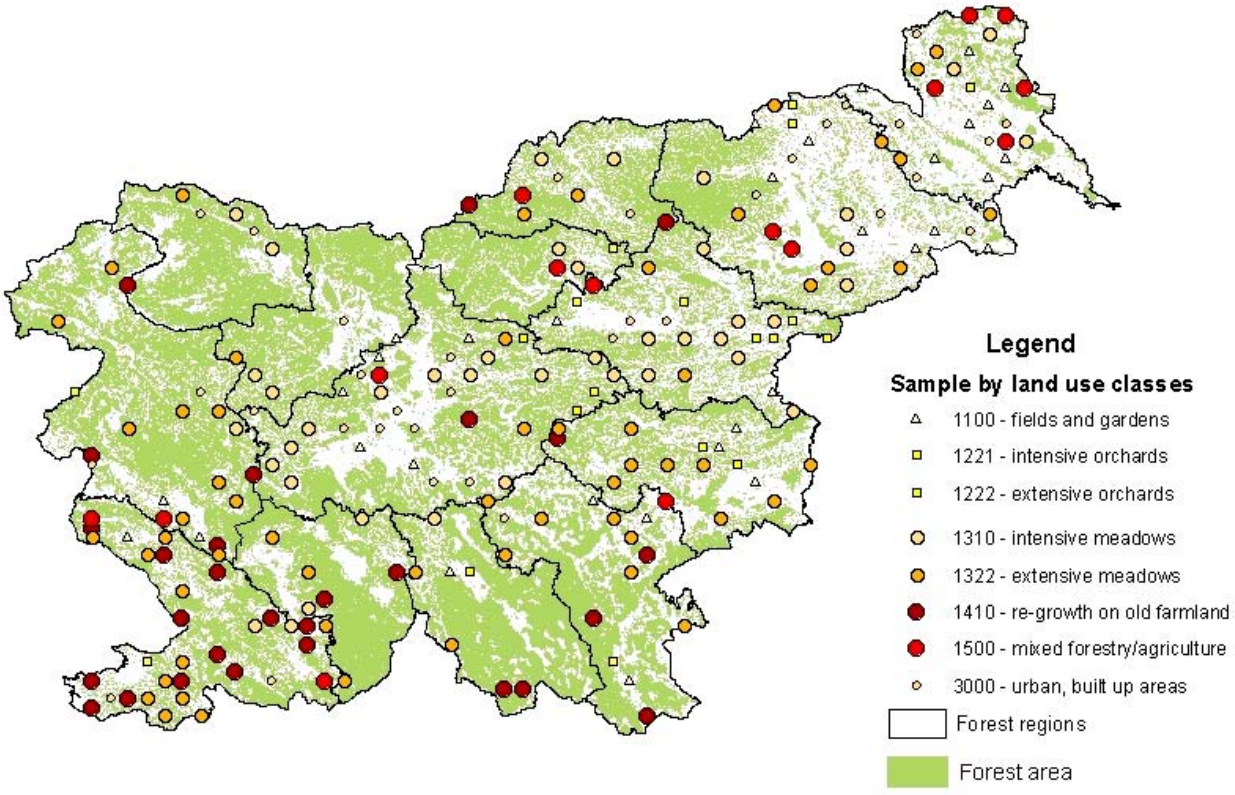
Sample selection

The following table and figure show the distribution of the sample using a 4x4 Km grid (the same used by Slovenia Forestry Institute for permanent forest sample plots) and including only the classes of interest.

Summary of sample selection

Code	Land use classes	Total area	Total 4x4km points	Remarks	selection frequency	Selected points
1100	Fields and gardens	213,985	136	Very low sample	1on4	32
1221	Intensive orchard	5,049	2	All-orchards aggregated	1on1	18
1222	Extensive orchard	19,849	16			
1310	Intensive meadow	159,652	101	Low sample	1on2	42
1322	Extensive meadow	187,930	118	Low sample	1on2	58
1410	Re-growth on old farmland	25,246	11	double sample	2on1	28
1500	Mixed use (agric. and forestry)	18,953	15	Full sample	1on1	15
3000	Urban and built up areas, roads	108,194	68	Low sample	1on2	33
			471			227

Sample distribution map:



Example of ortophoto with land use class (red) and crown cover types (yellow). The land use class of the selected class polygon is 1410 (re-growth in abandoned farmland). The Crown Type classes are: 3, 4, 5, and 6

Field measurement work in phase 2:

In order to calculate the average amount of wood stock (and increment) for all the cover types described above, a subset of the 227 sampling units was randomly selected for field measurement.

Smaller polygons of individual woody cover types were measured entirely. In bigger polygons, the measurements were done in representative sub-plots of varying size, depending on the woody cover type concerned, as follows:

Sizes of sample plots for wood stock measurements in different woody cover types

Plot size	Cover type
20 x 20 m	**01** - Bushes and young trees, **04** - Young forest stand (up to the pole stands)
30 x 30 m	**02** - Intensive orchard, **03** - Extensive orchard, **05** - Middle-age forest stand
40 x 40 m	**06** - Grown-up forest stand
30 m	**09** - Lines of trees with crown diameter under 8 m, **10 -** Lines of trees with crown diameter above 8 m

The position of the plot inside the polygon was marked on the map and, in case of lines of trees, the measured part was marked.

In every land use unit, up to 5 individual trees of the most frequent woody cover types in the unit were measured.

In all woody cover types, trees and bushes from a diameter of 5 cm onwards were measured.

In order to determine the tariffs for calculation of wood stock (and also increment) in every polygon the height of three thickest trees were measured. For individual trees, the height was measured every 5 or 10 trees, specifying the diameter and species.

The calculation of the average wood stock for individual land use types (in m3/ha) was done in two modes:

Direct mode

Calculation of average wood stock value for individual non-forest land use types directly through shares of individual woody cover types inside individual land use types – on the basis of a known average wood stock (in m3/ha) of different woody cover types. Calculation was faster and simpler but it did not provide the calculation of precision or confidence interval of the average wood stock value for an individual non-forest land use type.

Indirect mode

Calculation of average wood stock value for individual non-forest land use types through calculated average wood stock values of individual land use units (from 227), which provides calculation of precision or confidence interval of the average wood stock value for an individual non-forest land use type.

The list and location of the land units selected for field measurements is given in the Table below:

Ljubljana:

Nr	Unit number	Land use code	Framework of present woody cover types (approximately according to representation)	Location
1.	1159	3000	6, 5, 10, 8, 7, 1, 9	Dolsko
2.	1227	1310	6, 5, 4, 8, 7, 9, 10	Zagorje
3.	1217	3000	9, 10, 8, 7, 1	Medvode
4.	843	3000	9, 7, 8, 5, 10, 2, 3	Ponova vas by Grosuplje
5.	1273	1322	6, 5, 9, 7, 1	South of Železniki
6.	897	1310	4, 8, 7	Hotedrščica
7.	835	1310	5	Logatec
8.	1031	1221	2	Ljubljana-Bizovik
9.	1103	1221	2	Podkum

Brežice:

Nr	Unit number	Land use code	Framework of present woody cover types (approximately according to representation)	Location
1.	793	1500	6, 5, 10, 9, 8, 1	Škocjan by Otočec
2.	921	1322	5	Raka
3.	917	1322	5, 6, 4, 8, 7, 1, 9	Tržišče
4.	923	1221	2	Krško
5.	984	1221	2	Brestanica-Sevnica

Note: On one of plots 793 or. 917 measure two polygons of mature trees or two plots in mature tree stands (6).
On plot 793 measure 3 polygons of forest trees in lines with thick trees (10).

Celje:

Nr	Unit number	Land use code	Framework of present woody cover types (approximately according to representation)	Location
1.	1545	1500	5, 4, 6, 9, 7, 1	North of Polzela
2.	1611	1322	5, 9, 10, 8	Dobrna
3.	1301	1310	6, 4, 8	Loka
4.	1672	1222	3	Velenje
5.	1366	1222	3	Šmarje pri Jelšah
6.	1481	1222	3	Braslovče
7.	1487	1222	3, 5	Vojnik

Note: On one of plots 1545 or. 1672 measure two polygons of mature trees or two plots in mature tree stands (6).
On plot 1611 measure 3 polygons of forest trees in lines with thick trees (10).

Maribor:

Nr	Unit number	Land use code	Framework of present woody cover types (approximately according to representation)	Location
1.	2003	1322	5, 8, 7, 1	Cerkvenjak
2.	2125	3000	8, 10, 4, 1, 9, 3	Northeast of Maribor
3.	2123	1222	3	Šentilj
4.	2186	1222	3, 4, 1	Šentilj

Sežana:

Nr	Unit number	Land use code	Framework of present woody cover types (approximately according to representation)	Location
1.	639	1322	1, 9, 7, 4, 10	Štanjel
2.	451	1322	9, 7, 1	Divača
3.	269	1410	5, 4, 8, 7, 1	Knežak-Ilirska Bistrica
4.	2517	1410	5	Obrov

Survey results

1 – CROWN COVER

Average - percent crown cover

LU class	# Units	% all Crown Types	% lower veget.	% tree cover	Crown types (CT) Bushes 1	Intens. Orchard 2	Extens. Orchard 3	Young Forest 4	Middle Forest 5	Grown Forest 6	Small Trees 7	Large Trees 8	Small-trees line 9	Big-trees line 10
1100	32	**2.3**	**0.4**	**1.9**	0.3		0.0	0.0	0.5	0.6	0.1	0.1	0.4	0.0
1221	2	**64.5**		**64.5**		58.5				6.0				
1222	16	**38.4**	**11.7**	**26.7**	5.8	1.9	6.1	5.9	12.3	0.6	1.3	0.8	3.4	0.4
1310	42	**5.9**	**0.9**	**5.0**	0.5	0.0	0.2	0.4	0.7	2.4	0.4	0.4	0.8	0.1
1322	58	**14.5**	**2.9**	**11.6**	1.0		0.0	1.9	2.8	5.1	0.5	0.4	2.6	0.2
1410	28	**57.4**	**20.0**	**37.5**	1.2		0.1	18.8	23.9	11.7	0.4	0.2	1.0	0.1
1500	15	**63.5**	**6.0**	**57.5**	1.6			4.4	20.7	33.0	0.2	0.3	2.6	0.7
3000	33	**11.1**	**1.8**	**9.4**	1.7	0.3	0.3	0.1	1.7	3.4	0.5	0.5	2.2	0.4
ALL	227	**21.5**	**4.9**	**16.6**	1.3	0.9	0.5	3.6	6.3	6.0	0.5	0.4	1.7	0.2

Coefficient of Variation - percent crown cover

1100	32	**129**	**268**	**139**	299		566	330	402	173	247	247	195	218
1221	2	**54**		**54**		45				141				
1222	16	**39**	**102**	**53**	102	400	228	195	125	232	170	219	193	400
1310	42	**79**	**148**	**79**	113	525	319	279	186	131	232	151	133	217
1322	58	**63**	**118**	**75**	81		540	177	149	131	95	148	179	185
1410	28	**52**	**99**	**69**	144		529	106	94	146	170	209	144	388
1500	15	**26**	**142**	**36**	215			196	101	98	271	265	226	304
3000	33	**64**	**88**	**73**	83	320	240	391	161	183	67	97	127	152
ALL	227	**116**	**208**	**124**	187	763	734	276	212	222	191	190	210	339

lower veget = CT 1 and 4 tree cover = all other CT

2 - STOCKING AND INCREMENT

Class code	Mean Stocking m^3/ha	Mean Increment m^3/ha/year	sd Stock	sd Incr	CV%	CV%	Area ha	total stock m^3/ha	total increment m^3/ha/year
1100	3.0	0.10	3.6	0.12	119.56	121.69	213,985	649,466	21,958
1221	33.1	1.12	26.1	0.89	78.84	79.53	5,049	167,004	5,675
1222	32.1	1.14	15.7	0.54	48.94	47.83	19,849	637,212	22,591
1310	8.5	0.28	7.0	0.24	82.43	85.27	159,652	1,358,629	44,579
1322	19.5	0.67	14.4	0.50	73.74	73.77	187,930	3,670,979	126,499
1410	57.4	2.16	36.2	1.29	63.11	59.84	25,246	1,449,435	54,498
1500	94.6	3.30	46.2	1.54	48.82	46.58	18,953	1,792,963	62,624
3000	15.6	0.51	12.6	0.43	80.44	83.75	108,194	1,691,725	55,430

Annex 7. SWEIS in energy units

SWEIS - Slovenia Wood Energy Information System. National level statistics.

Values in PJ.

	1995	1996	1997	1998	1999	2000	2001	2002
Production								**14.0**
Fuelwood								
Forests								**6.9**
Other landuses								**1.9**
Industries (residues)	**4.9**	4.7	4.5	4.4	4.2	4.1	3.9	3.8
Charcoal	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.05**	**0.05**	**0.06**
Black Liquor	1.45	1.45	1.45	1.45	1.45	1.45	1.45	**1.45**
Import								
Fuelwood	**0.1**	**0.0**	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**
Charcoal	**0.07**	**0.06**	**0.06**	**0.06**	**0.06**	**0.05**	**0.05**	**0.06**
Black Liquor								
Export								
Fuelwood	**0.5**	**0.0**	**0.0**	**0.6**	**0.5**	**0.4**	**0.4**	**0.4**
Charcoal								
Black Liquor								
Consumption								
Household Sector								
Fuelwood								**8.7**
Charcoal	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11
Black Liquor								
Other Sectors (industrial, public, etc.)								
Fuelwood			**2.9**					3.4
Charcoal								
Black Liquor	1.45	1.45	1.45	1.45	1.45	1.45	1.45	**1.45**

Notes:

Figures in bold represent reference values. Other figures are extrapolated values.

For additional details see notes under Table 1 and text of Chapter 2. 2 ”SWEIS”.