AREA-BASED WOODFUEL FLOW ANALYSIS USING THE *WISDOM* APPROACH:
A CASE STUDY FOR SLOVENIA

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ABSTRACT: Slovenia is a well-endowed biomass country but the true value of this richness, especially as an accessible source of energy for the industry, has yet to be recognized by Slovenian forestry, energy and rural development policies. Current demand for wood fuels (especially fuelwood,) is concentrated in rural areas mainly for heating purposes. Other uses such as district heating and combined heat and power plants (CHP) are still marginal in Slovenia. However, their demand may grow as viable energy option, considering new international energy and environmental policies and the entry of Slovenia in the European Union. For these reasons, it is essential to know the true current amount of consumption and how much and where and what type of woody biomass could be potentially used. This information is crucial for the development of future forestry and energy plans and policies. The study uses the Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) methodology [1] for the spatial representation of the use of woody biomass for energy in Slovenia, its sustainable resource base and to explore its potentialities as a local, cost-effective and environmentally friendly source of energy.

Keywords: biomass resources; forestry; geographic information system

1 INTRODUCTION

Slovenia is a well-endowed biomass country but the true value of this richness, especially as an accessible source of energy for the industry, has yet to be recognized by the Slovenian forestry, energy and rural development policies. Current demand for wood fuels (especially fuelwood,) is concentrated in rural areas mainly for heating purposes. Other uses such as district heating and combined heat and power plants (CHP) are still marginal in Slovenia. However, their demand may grow as viable energy option, considering new international energy and environmental policies and the entry of Slovenia in the European Union.

For these reasons, there is an urgent need to assess current consumption patterns and to know how much, where and what type of woodfuel can be used as a basis for forestry and energy planning and policy development processes. Filling this information gap is one of the objectives of the on-going Project "Supply and Utilization of Bioenergy to Promote Sustainable Forest Management" executed by the Slovenia Forestry Service (SFS) with support from the FAO Technical Cooperation Programme .

This paper describes the results achieved so far in the analysis of woodfuel flows in Slovenia based on the application of the Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) methodology [1]. WISDOM is a spatially-explicit method developed by FAO and the National University of Mexico (UNAM) 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 the following steps:
Definition of the spatial unit of analysis.
Development of the DEMAND module.
Development of the SUPPLY module.
Development of the INTEGRATION module and definition of priority areas.

2 WISDOM SLOVENIA

The phases of WISDOM development so far completed for the Slovenia case study include the review, harmonization and integration, at the lowest administrative level, of the available information related to supply and demand of fuelwood[i], the spatial representation of current household consumption levels and forest supply sources. On-going activities include a survey of non-forest fuelwood supply sources, for which no data existed, and the collection of data from other sectors.

2.1 Spatial level of analysis

The digital map of Cadastral Communities (2696 units) was used as spatial basis of analysis.

Figure 1: Cadastral Communities (2696 units, grey shades) and Municipalities (196 units).

3   DEMAND MODULE

As often happens in wood energy statistics, there is a strong interrelation between fuelwood consumption and production estimates. Most common practice is to equal fuelwood production to the estimated consumption, due to lack of production data and under the consideration that production is demand-driven [9]. On the contrary, in case of Slovenia it appears that fuelwood consumption estimates were generally derived from the forestry statistics referring to fuelwood production, which tended to underestimate the role of woodfuels in the country. An essential element of this study was therefore to make an independent estimation of fuelwood consumption.

New national estimates of household fuelwood consumption were produced, based on recent census data and other sources. According to Census 2002 [4], 30 percent of Slovenia households use primarily or exclusively wood for house heating (Fig 2).
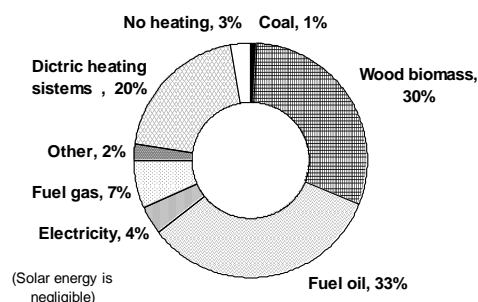

Figure 2: Share of Slovenia apartments according to heating fuel.

Applying energy requirements for house heating [5] and assuming standard conversion efficiency rates [7], the amount of wood used for house heating was estimated at 1 million m^3, which may be expanded to some 1.3 to include wood used for cooking and water heating [6].

The spatial distribution of fuelwood consumption by households and existing biomass installations is shown in Figure 3.

To better understand fuelwood use and users in the country, a users profile is being developed, at the level of Municipalities, based on recent censuses of households and agricultural holdings. Data on other identified users of woody biomass, such as the wood processing industry and existing biomass installations, is currently being collected and analyzed.
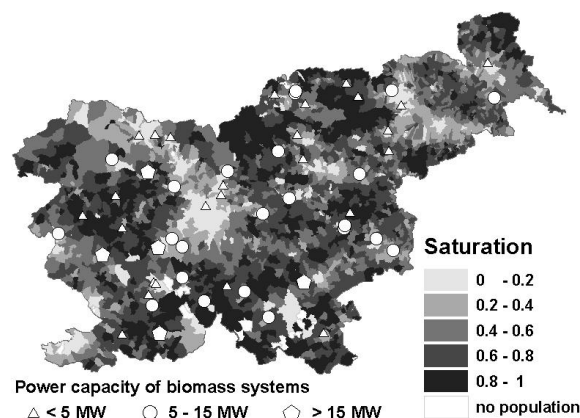
Figure 3: Saturation of fuelwood use (fraction of households using wood for heating) and distribution of biomass systems.

4   SUPPLY MODULE

Main data sources to assess current and potential fuelwood supply from forest resources was the database of forest compartments maintained by the Slovenia Forest Service. In addition, to fill the information gap on stocking and productivity of non-forest areas, a rapid two-phase survey is currently under completion.

The forest compartment database and digital map provided excellent information on stand characteristics and management prescriptions as well as on allowable cut by wood assortments and actually extracted volumes. In these statistics "fuelwood" is accounted as a separate assortment although it is generally accepted that important fractions of other wood assortments are also used as fuel [8]. However, the Statistical Office of Slovenia (SOS), which is the main reference for most international and national analysts, seems to refer exclusively to this assortment for quantifying fuelwood production (and consumption) in Slovenia. A comparison of SOS forest products statistics with households consumption estimates (Table 1) reveals that the "Fuelwood" category represents only a small fraction (some 20-30%) of the volumes actually used as fuel.

Table 1: Wood production statistics and household consumption estimates

Production of row wood categories ('000 m3)	2000	2001	2002
TOTAL wood production	2253	2257	2283
Logs	1120	1144	1164
Pulpwood	396	410	414
Other industrial wood	205	408	425
Fuelwood	532	295	280
Source: [3]			
Estimated annual fuelwood consumption by Slovenia households ('000 m3)		Ca. 1000 - 1300	
Source: elaboration of [4], [5], [6] and [7]			

It is evident that the reported fuelwood production cannot satisfy the needs of over 230 000 dwellings that use wood for house heating, cooking and water heating, to consider only the household sector. Fuelwood production is definitely much higher than reported in

official statistics and probably hidden under other categories. In addition, there may be other supply sources not accounted for in forestry statistics such as "informal" forest extraction and, most relevant, wood supply from non-forest areas.

The database of forest compartments provide detailed statistics on annual allowable cut as well as on actual extraction for main wood assortments and species groups, which allows to estimate/infer the amount of wood that is currently used as fuel or that could become a sustainable source in the future. The assortments considered were the following:

- Assortments from species group "Other hard broad leaved trees" (Carpinus, Ostrya, Fraxinus ornus, Robinia, Acer campestre, Sorbus, Quercus pubescens). This is the main assortment recognized as "fuelwood".

- Non-timber assortments commonly preferred as fuel (including Beech, Oak spp., Chestnut, other quality broadleaves and Larch).

- Non-timber assortments of all species (all conifers included).

- All "Timber" assortments (definitely not for energy use)

The volumes were estimates as both allowable cut and actually extracted amounts. Table 2 shows the annual wood production (allowable and actually extracted) by main assortments. The ratio between actual extraction and the allowable cut depends mainly on ownership factors [8], while physical accessibility (distance from roads and slope factors) doesn't seem to produce a significant influence. The ratio appeared to be, on average, 0.54 for forests owned by privates, rural communities and religious institutions and 0.76 for state forests. In other words, the efficiency of execution of allowable cuts is inversely related to the fragmentation of forest ownership, whose spatial pattern is shown in Figure 4. 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.

Table 2: Annual wood production (average 1991-2001) by main assortment groups. Wood production statistics vs. consumption estimates

	Allowable cut	Volumes extracted
	'000 m3	
Fuelwood assortments (selected hard Broadleaved species)	226	132
Non-timber assortments commonly preferred as fuel	1,407	840
Non-timber assortments of all species (all conifers included)	2,148	1,283
All assortments (timber and non-timber)	3,927	2,366

Definitely, ownership patterns and incentives for the creation of consortia of owners will be core issues in future forest policy formulations.
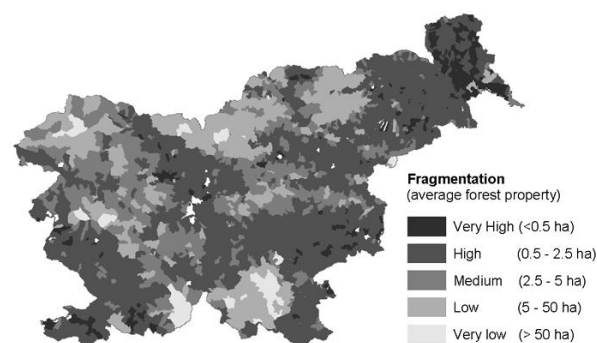

Figure 4: Forest property fragmentation

4.1 Non-forest woody biomass

Slovenia's richness in woody biomass goes well beyond managed forests but no information existed on wood stocking and potential productivity outside them. To fill this gap, a rapid two-phase sample survey of non-forest woody biomass is under completion. The 2002 land use map was used as basis for the survey design and its 22 land use classes for the stratification.

A systematic sample of all non-forest classes was defined, composed by 231 sampling points (Figure 5), and each polygon defined by the points was interpreted for crown cover types on ortorectified aerial photos (phase-one). A subset of photo sample is currently being surveyed in the field in order to relate crown cover parameters to volumes and potential productivity (phase-two). The study on abandoned farmland currently under completion by the Slovenian Forestry Institute will contribute to the development of future supply scenarios.
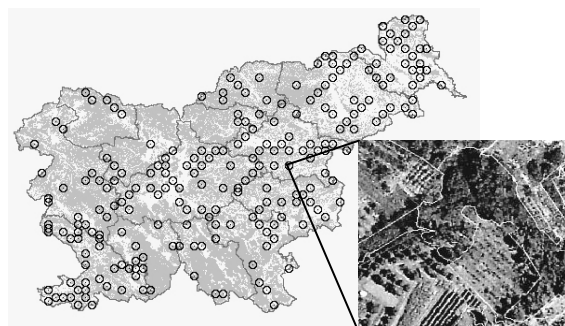
Figure 5: Distribution of sampling units of the non-forest woody biomass survey. (Forest area in light-grey shade); example of ortophoto showing dense wood growth in abandoned farmlands.

4.2 Indirect sources of woody biomass

Wood waste from wood processing industries represents another important woodfuel source. There are around 800 wood processing companies in Slovenia [10], which are currently being surveyed for wood waste on a sample basis.

5   INTEGRATION MODULE

A GIS database was created to include information on fuelwood demand and supply so far aggregated for each of the 2696 Cadastral Communities. The first level of integration of supply and demand variables concerned the balance between households' fuelwood consumption (for heating or heating and cooking) and production

scenarios (limited, for the time being, to recorded forest production data). Several supply/demand balances were estimated with reference to different consumption levels and wood assortments, which were quantified according to management plans prescriptions (allowable cut) as well as to the fraction of recorded extraction. National-level balances are given in Table 3, while the spatial pattern of two situations (shaded in the table) are shown in Figure 6.

Table 3: Fuelwood balance (estimated household consumption for heating minus production) by main assortment groups. Shaded cases are shown in Figure 6.

	Allowable cut	Recorded extraction
	'000 m^3	
Fuelwood assortments (selected hard Broadleaved species)	-760	-850
Non-timber assortments commonly preferred as fuel	400	-150
Non-timber assortments of all species (all conifers included)	1200	300

Deficit

Balanced

Surplus
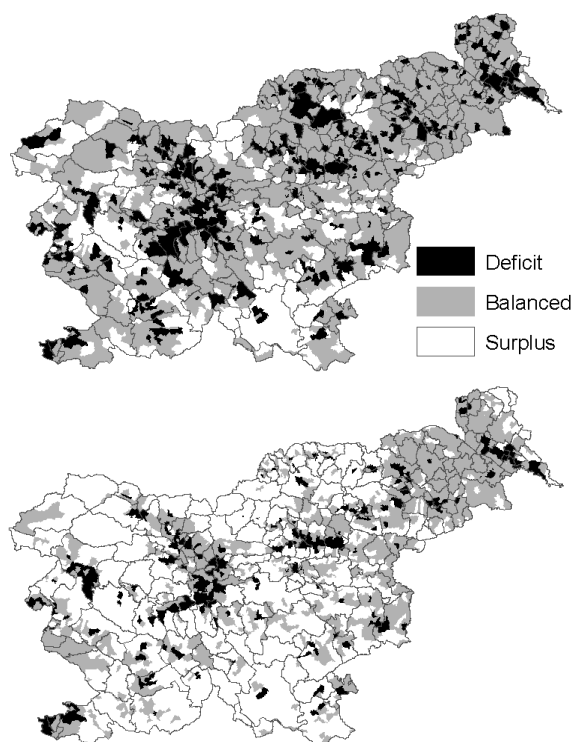
Figure 6: Fuelwood balance between households' consumption for heating minus recorded extraction of non-timber assortments normally preferred as fuel (top) and minus full allowable cut of all non-timber assortments (bottom).

This first level of integration allows to identify the areas of the country where there could be an adequate sustainable resource base to feed advanced wood energy projects.

As additional parameters are collected and fed into the Demand and Supply modules, the integration module will develop further. A simple indexing of all the variables and further ranking will conduct to group Cadastral Communities at local community level and into various categories and priority levels. The main results of

the WISDOM analysis will be presented at local community level and will be used as basic information for decision making and strategic planning.

6 CONCLUSIONS

The gross discrepancy between fuelwood production reported in official national statistics and the amount of wood truly used as fuel misleads the analysis of forest role in the energy sector as well as the analysis of the share of wood fuels in the national energy mix. It is essential to improve and complete production and consumption data in order to reveal the true role and potential of bioenergy in Slovenia.

It is hoped that WISDOM Slovenia will enhance the understanding and visibility of the wood energy potential in the country and will favor the interaction between the forestry, agriculture and energy sectors for the formulation and implementation of sound forestry and bioenergy strategies.

Data and conclusions from WISDOM Slovenia will be used as basic guidelines for preparation of a new "National programme and Action plan for use of wood biomass", which should be prepared by end 2005.

4.3 References

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[i] Fuelwood is by far the main type of woodfuel in Slovenia, since charcoal and black liquor are rather negligible. Therefore, in this paper the term "fuelwood" will be used, rather than "woodfuel".