Roundwood flow analysis in Slovenia

Mitja Piškur, Nike Krajnc

Abstract – Nacrtak

On the basis of roundwood flow model, two roundwood balances were prepared. A wide range of available data was taken into consideration; data quality was evaluated and a proposal for improving their quality developed. Results of roundwood balance in the reference year 2004 showed that if official data for annual removals are considered, a lack of 536,000 m³ occurs. In the case of modelled (enlarged) removals, a roundwood balance is positive. Wood flow and data analysis should play an important role as part of strategic planning and decision making at sectorial, local, regional and national levels.

Keywords: roundwood, roundwood balance, roundwood flow analysis, MFA, forest industry, home consumption, Slovenia

1. Introduction – *Uvod*

For a strategic development planning in the sphere of branches associated with wood, roundwood flow analyses are needed. A research into roundwood flows enables an overview of a momentary situation and serves as a basis for any decisions to be made on development of the forestry and wood processing sectors. In the last twenty years, roundwood balances and flow analyses have been made for numerous countries (e.g. Palmer 2000, Binder et al. 2003, Hashimoto and Moriguchi 2004, Hekkert et. al. 2000, Krajnc and Piškur 2006), which served as a basis for development planning or as a basis for the assessment of illegal removals in forests. Strategic development planning of the branches associated with wood requires information on material flows of wood in wood production chain. Some data and investigation results show that the state of affairs in this respect has been poorly researched in Slovenia.

With roundwood flow analysis, the balance between production and primary use of roundwood in Slovenia is established. The obtained relations indicate the adjustment between both productions, quality and availability of data, import-export balance, and significance of wood in home consumption.

2. Working methods – *Metode rada*

Owing to the very specific conditions, a model (Fig. 1) was made, which in fact covers the entire complexity of wood flow in Slovenia (Krajnc and Piškur 2006). As a basis, the material flow model (MFA) was used (Bruner and Rechberger 2004). The principles of the products' life cycle assessment (LCA)(e.g. Jensen et al. 1997) were also applied, considering that material flow analysis is its component part. MFA clearly presents the material flows, showing correlations between the sources, users and flows. The MFA results are controlled by roundwood balance.

To quantify the wood flow in Slovenia, a method was applied for analysing the existing and available data on production of roundwood and its further use. With the synthesis method, the gathered data were incorporated in two balances, i.e. roundwood balance and wood wastes balance (Krajnc and Piškur 2006). All the data and balances relate to the reference year 2004.

By taking import and export into account, the relation between net removals in the forests and the estimated roundwood use was named roundwood balance (B_1) and calculated according to the following formula:

$$B_1 = P_{\text{neto}} - S_{\text{OKL}} - I_{\text{OKL}} + U_{\text{OKL}} \qquad (1)$$

P_{neto} – Net removals in the reference year (m³)

S_{OKL} – Registered consumption of roundwood in industry, households and energy production

I_{OKL} – Total roundwood export

U_{OKL} – Total roundwood import

The model of roundwood flows is defined with:
⇒ Roundwood removals and production,
⇒ Roundwood import and export,
⇒ Roundwood use in wood processing,
⇒ Roundwood use in households,
⇒ Roundwood use for energy production.

When assessing the actual removals in forests, two different approaches were used, i.e. »top down« and »bottom up«. For the first evaluation of roundwood balance, official data were used for net removals and forest timber assortment (TQA). For the second evaluation, on the other hand, net removals were evaluated on the basis of total registered roundwood use, when the TQA structure was partially changed as well. In view of the registered or estimated use, net removals in privately owned forests were increased. The disunion between the registered removals in privately owned forests has also been noted by Veselič (2004), Medved (2005) and Piškur (2005). The amount of removals in state owned forests was not changed.

The statistics regarding import and export of goods is monitored by the Statistical Office of the Republic of Slovenia (SURS), whereas the data are collected by the Customs Office of the RS. Import and export to EU countries are covered by the Intrastat system, the data on import and export from non-EU countries by the Extrastat system. The data on the amounts of separate combined classes of forest timber assortment were surveyed by Combined Nomenclature (CN8). The basic data on roundwood import and export (in kg and m³) were obtained from the statistic database of SURS (2006c). On the basis of structure
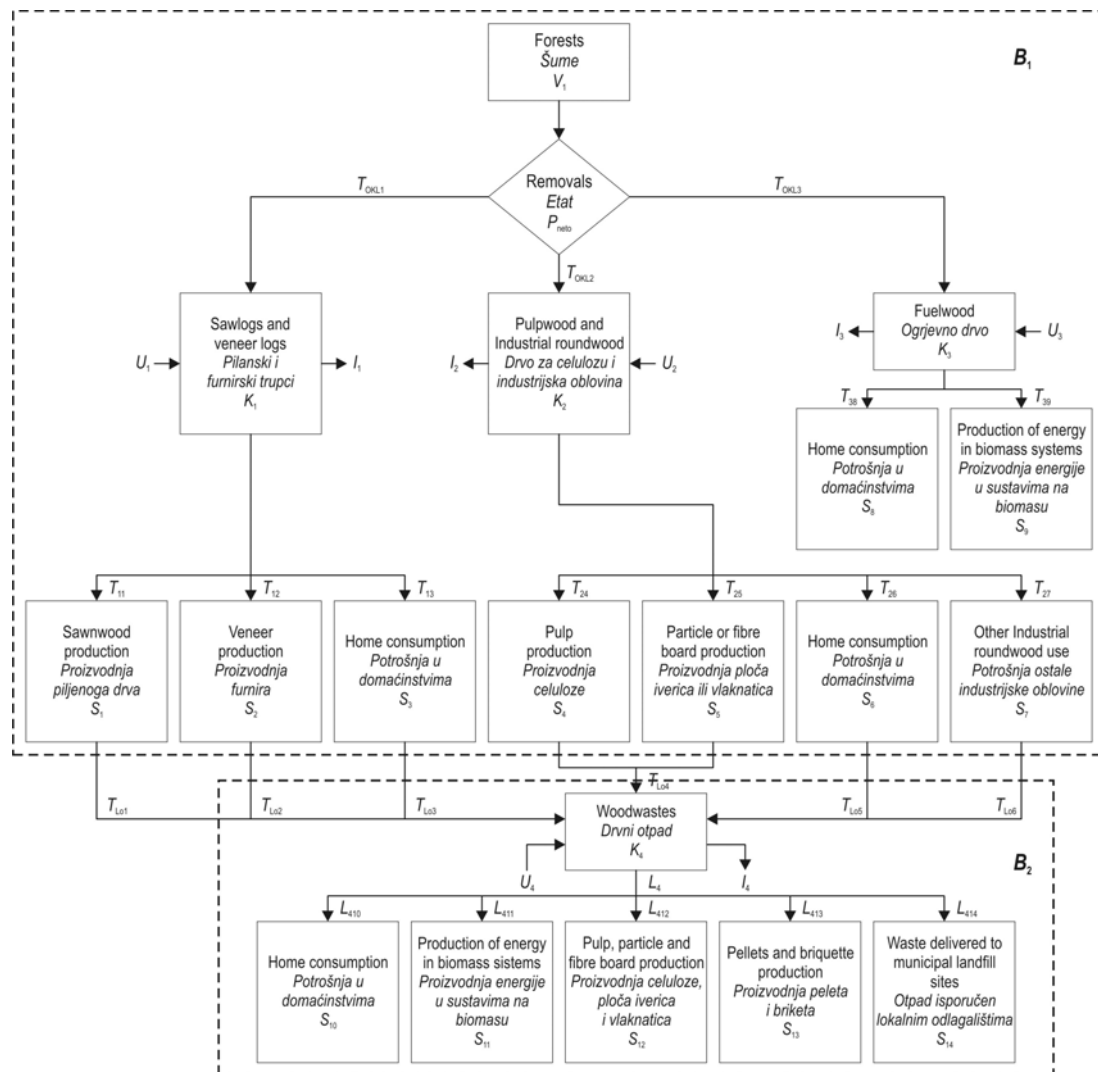

Fig. 1 Roundwood and wood wastes model in Slovenia
Slika 1. Prikaz modela potrošnje drva u Sloveniji

of databases, roundwood was divided (separately for coniferous and deciduous trees) into:

⇒ saw and veneer logs (L),

⇒ pulpwood (PW) and other industrial round-wood (OIR),

⇒ fuelwood (WF).

Roundwood use is the highest and from the aspect of economy also the most important in industry. Roundwood use in woodworking activities (S_{indOKL}) is the sum of:

⇒ 1. production of sawnwood (S_1)

⇒ 2. production of plywood and veneer (S_2)

⇒ 3. production of wood pulp (S_4)

⇒ 4. production of particle boards and fibre-boards (S_5)

⇒ 5. use of other industrial wood (S_7)

The estimate of roundwood use in woodworking activities is based on official data (SURS), on research carried out (e.g. Internova 2006, ZGS 2006, GIS 2004a and ICP 2006 questionnaires), and on data obtained directly from firms.

The entire home consumption was divided in use of saw and veneer logs, use of other industrial wood, and use of fuelwood. The data on home use were obtained from the inventory of rural economies (SURS 2000, 2003, 2005), results of the questionnaires filled by forest owners in the Council of Solčava (GIS 2002), results of the general questionnaire filled by forest owners (GIS 1995), and results of the analysis of use of wood for heating purpose in Slovenia (SURS 2006a in 2006b). On the basis of the existing results, use of roundwood for heating purposes and use of logs

and other industrial wood in households was estimated.

The quantities of roundwood, used as wood for energy production, were estimated separately for households and energy systems (heating plants, hydroelectric power stations, the systems of simultaneous production of heat and electricity). The data on roundwood use for energy production purposes in larger systems were obtained from the questionnaire on wood biomass producers (GIS 2004b), which enclosed only major and registered producers of wood biomass. The data on wood use for fuel were obtained from the questionnaire on energy use in households (SURS 2006a, b).

3. Results and discussion – *Rezultati i rasprava*

On the basis of the prepared model and the objectives of our research, two balances were made. The results are presented in partial frameworks of wood flow in Slovenia, with the frameworks interacting with each other and supplementing each other as to their context at the same time. The final and most essential result is the presentation of two variants of roundwood wood balance in Slovenia, i.e.:

⇒ Roundwood official balance

⇒ Roundwood model balance

As far as removals are concerned, it was assumed that the data on quantities used in production of forest timber assortments in state owned forests were realistic, and hence they were not altered. To a great
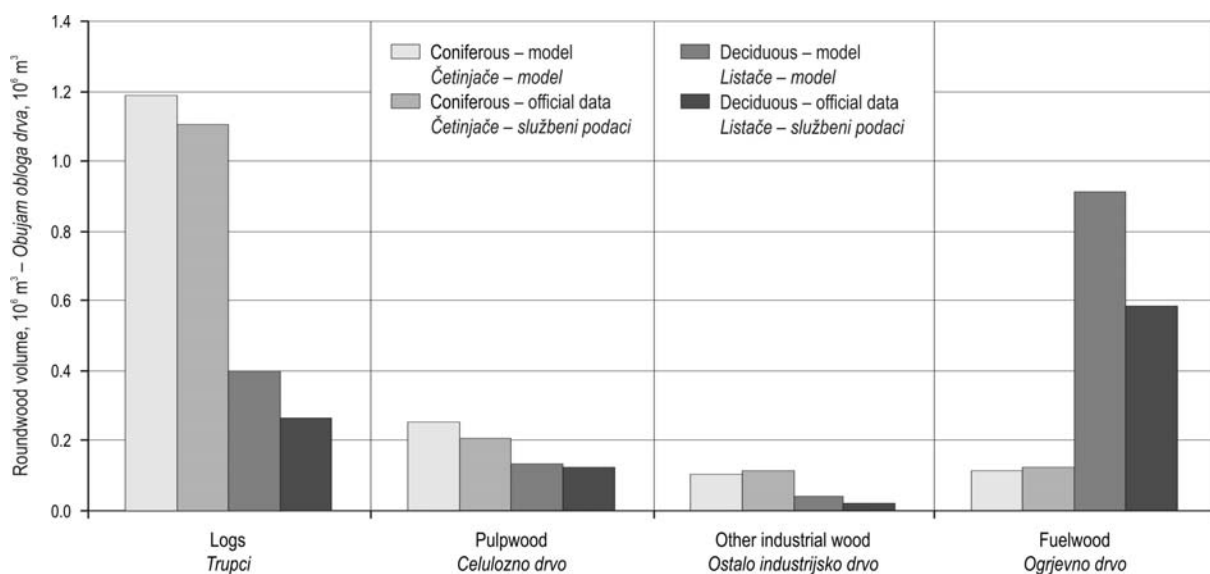

Fig. 2 Comparison between official and model net removals (year 2004)
Slika 2. *Usporedba stvarno ostvarenoga i oblikovanoga modela neto etata (godina 2004)*

extent, however, we altered the data on removals in other forests, i.e. by increasing the removals of deciduous trees in other forests with the factor 1.8, and the removals of conifers with the factor 1.1. Our comparison between the official and model net removals is presented in Figure 2.

In 2004, 52,000 m^3 of logs were imported according to our calculations, 351,000 m^3 of pulpwood and other industrial wood, and 8,500 m^3 of fuelwood. In the same year, Slovenia exported 108,000 m^3 of saw and veneer logs, 76,000 m^3 of pulpwood and other industrial wood, and 63,000 m^3 of fuelwood. When comparing the import and export, we can conclude that in 2004 Slovenia was a net exporter of logs and wood for fuel and a great net importer of roundwood used for cellulose, chip and fibre boards, and other industrial wood.

The use of wood in woodworking activities was divided as follows: production of sawnwood and veneer, production of wood pulp, particle boards and fibreboards, and use of other industrial wood. The quantities of roundwood are shown by individual activities in Table 1 (Slovene Forestry Institute's own calculations).

The greatest amount of roundwood is used in the production of sawnwood, which originates mostly from Slovene forests. On the basis of our calculations and gathered data we estimate that altogether 1,410,000 m^3 of logs were sawn up in 2004, 1,100,000 m^3 of which were conifers and 310,000 m^3 deciduous. In registered companies, 1,243,000 m^3 of saw logs were sawn. The difference (167,000 m^3) was sawn up for home use by unregistered sawmills and forest owners. It is interesting that in 1985 the official production of sawnwood was 1,078,000 m^3, 72% of which went to the sawnwood of coniferous trees. By

allowing for the yield factor during sawing up (0.67), the use was 1,610,000 m^3 of saw logs. It is a very difficult task to estimate the quantities of roundwood used in sawmills due to insufficient and inconsistent data. The poor quality of data is also indicated by the former estimates of roundwood quantities sawn up in Slovenia (from 760,000 m^3 to 1,960,000 m^3) and by various data on the number of corporate bodies registered for wood cutting and planning. These data indicate that more accurate analyses are to be implicitly made into the state of sawmilling industry in Slovenia.

In 2004, the production of wood pulp was a significant wood consumer in Slovenia. Between 2000 and 2005, roundwood use in the production of wood pulp oscillated around 500,000 m^3. Use of roundwood for the production of chemical wood pulp after closing of the production plant within Vipap Videm Krško d.d. ceased in 2006. In the last few years, on the other hand, the quantity of roundwood for the production of mechanical wood pulp has increased (66,000 m^3 in 2003, and 117,000 m^3 in 2004).

The third biggest consumer of industrial roundwood is the production of chip and fibre boards, by which about 200,000 m^3 of particularly deciduous tree wood are used annually.

The registered quantities of roundwood, which enter the production of veneer in Slovenia, amounted to 91.000 m^3 in 2004. Under the production of veneer, the production of sliced and peleed veneer was taken into consideration.

Other industrial roundwood, which is processed in industry, encloses pitwood, wood for the production of tannin, and wood for the production of poles. Industrial use of this kind of roundwood has been greatly reduced in comparison with the situation

Table 1 Use of roundwood in woodworking industry for the year 2004 (in m^3)
Tablica 1. Potrošnja drva u drvnoj industriji za 2004. godinu (u m^3)

Use of wood in woodworking industry *Potrošnja drva u industriji*	Total *Ukupno*	Originating from import *Drvo iz uvoza*	Domestic wood *Drvo domaćega porijekla*
Production of sawnwood *Proizvodnja piljenoga drva*	1,243,000	14,000	1,229,000
Production of veneer *Proizvodnja furnira*	91,000	38,000	53,000
Production of wood pulp, particleboards and fibreboards *Proizvodnja celuloze, iverica i vlaknatica*	693,000	309,000	384,000
Use of other industrial wood *Potrošnja drugoga industrijskoga drva*	63,000	27,000	36,000
Together *Ukupno*	2,090,000	388,000	1,702,000

Table 2 Material flows and roundwood balance in Slovenia (data are in m^3)
Tablica 2. *Tokovi sirovina i drvna bilanca Slovenije* (u m^3)

Components of net removals *Sastavnice službenoga neto etata*	T_{okl1} 1,371,668 L	T_{okl2} 454,186 OIR+PW	T_{okl3} 725,086 WF	P_{u_neto} 2,550,940 RW
Roundwood use in woodworking industry (S_1) *Potrošnja oblovine u drvnoj industriji* (S_1)	1,334,000	756,000		2,090,000
Home consumption (S_2) *Potrošnja u domaćinstvima* (S_2)	167,000	53,000	939,000	1,159,000
Roundwood use for energy production in biomass systems (S_3) *Potrošnja oblovine pri proizvodnji energije u sustavima na biomasu* (S_3)			3,000	3,000
Sum of roundwood use (S_{OKL}) *Ukupna potrošnja oblovine* (S_{OKL})	1,501,000	809,000	942,000	3,252,000
Import (U_{OKL}) *Uvoz* (U_{OKL})	52,000	351,000	9,000	412,000
Export (I_{OKL}) *Izvoz* (I_{OKL})	108,000	76,000	63,000	247,000
Official balance of roundwood (B_{1u}) ***Službena drvna bilanca*** (B_{1u})	**–185,332**	**–79,814**	**–270,914**	**–536,060**
Components of model net removals ***Sastavnice oblikovanoga neto etata***	T_{okl1} 1,583,000 L	T_{okl2} 531,100 OIR+PW	T_{okl3} 1,028,000 WF	P_{m_neto} 3,142,100 RW
Roundwood use in woodworking industry (S_1) *Potrošnja oblovine u drvnoj industriji* (S_1)	1,334,000	756,000		2,090,000
Home consumption (S_2) *Potrošnja u domaćinstvima* (S_2)	167,000	53,000	939,000	1,159,000
Roundwood use for energy production in biomass systems (S_3) *Potrošnja oblovine pri proizvodnji energije u sustavima na biomasu* (S_3)			3,000	3,000
Sum of roundwood use (S_{OKL}) *Ukupna potrošnja oblovine* (S_{OKL})	1,501,000	809,000	942,000	3,252,000
Import (U_{OKL}) *Uvoz* (U_{OKL})	52,000	351,000	9,000	412,000
Export (I_{OKL}) *Izvoz* (I_{OKL})	108,000	76,000	63,000	247,000
Model balance of roundwood (B_{1m}) ***Oblikovana drvna bilanca*** (B_{1m})	**26,000**	**–2,900**	**32,000**	**55,100**

Remark: RW – Roundwood, L – Logs, PW – Pulpwood, OIR – Other industrial wood, WF – Woodfuel
Napomena: RW – drvo, L – pilansko oblo drvo, PW – celulozno drvo, OIR – ostalo industrijsko drvo, WF – ogrjevno drvo

prior to 1990, when about 180,000 m^3 of other industrial wood used to enter the market from forest production. In 2004, on the other hand, the registered use of this kind of roundwood was merely 63,000 m^3.

The analysis of wood for household purposes has shown that most of the wood is used for heating and sanitary water heating. Three independent studies (SURS 2006a, b, ZGS 2005) have shown that households use more than 1,000,000 m^3 of wood per year for heating alone. A minor part of this wood are wood wastes and other wood mass. Apart from fuelwood, households also process and consume a little more than 220,000 m^3 of saw logs and other industrial wood per year. Our supposition is that households use for their own needs 167,000 m^3 of logs and 53,000 m^3 of other industrial wood.

According to the data obtained through the questionnaire initiated by GIS (2004b), less than 3,000 m^3 of roundwood per year is used by large energy production systems (remote systems for the heating of settlements, the systems of simultaneous production of electricity and heat, boilers in industry). These systems otherwise use almost exclusively wood residues and wastes left after wood processing and, partially, other wood mass.

Knowledge of individual utilizations of roundwood is of key importance for understanding the state of woodworking industry and for the elaboration of future development programs. In view of the data on roundwood use, 64% of all roundwood in Slovenia is used in woodworking industry, 36% in households, and negligibly little in energy production.

Joint results of the roundwood flow analysis – separately by each individual use – are presented in Table 2. Two different estimates are given. In the first, the basis is made up of the official net removals, whereas in the second estimate, the basis is the model assessment of net removals in forests. Roundwood use is divided in three groups of use (S_{1-3}) and in three groups in view of the forest timber assortments (K_{1-3}). The official roundwood balance (B_{1u}) was calculated by formula (2), the model balance (B_{1m}) by formula (3).

$$B_{1u} = P_{u\_neto} + U_0 - \sum_{i=1}^{3} S_i - I_0 =$$
$$= 2,552,940 + 412,000 - 3,252,000 - 247,000 =$$
$$= -536,000 \quad \text{m}^3 \qquad (2)$$

$$B_{1u} = P_{m\_neto} + U_0 - \sum_{i=1}^{3} S_i - I_0 =$$
$$= 3,142,000 + 412,000 - 3,252,000 - 247,000 =$$
$$= +55,100 \quad \text{m}^3 \qquad (3)$$

The differences between the official and model balances are large. There is a lack of more than 500,000 m^3 of roundwood (net) in the official balance in Slovenia. The largest deficit is related to fuelwood (more than 270,000 m^3) and logs (more than 185,000 m^3). The available data on use of roundwood for heating purposes are relatively solid (similar to the estimate of 1,000,000 m^3 from the sources by ZGS 2005, SURS 2006a, b), due to which the official figure on net removals for fuelwood (750,000 m^3) is too low.

As far as the model balance is concerned, the net removals were increased in view of the estimated use, which is presented in Table 2. In this case, the balance is positive. The production surplus is actually above the registered use of 55,100 m^3, which is

less than 2% of the entire net removals. We presume that the quantity of roundwood, which is used by larger energy production systems (S_9), is underestimated. The use of roundwood for household heating purposes is greatly reduced in the model as well. We also assess that the quantity of exported roundwood, which originates from privately owned forests, is greater and that it is not fully registered in SURS's databases. Owing to the stated assumptions we estimate that the model balance is nearer to the actual situation regarding the production and use of roundwood than the official balance.

4. Conclusion – *Zaključak*

Considering that high quality data are of key importance for making roundwood balances, the quality and availability of data should be well improved in the years to come. Furthermore, roundwood balances should be made annually. Thus a continued and high quality estimate of the current state would be provided. In the long run, on the other hand, we would be able to estimate the trends of future development in the branches of industry closely associated with forests and wood.

5. References – *Literatura*

Binder, C. R., Hofer, C., Wiek, A., Scholz, R. W., 2003: Transition process towards improved regional wood flow by integrating material flux analysis and agent analysis: The case of Appenzell Ausserrhoden,Switzerland. Working paper 39. ETH Eidgenossische Technicshe Hochschule Zurich, Zurich, p. 1–24.

Bruner, P. H., Rechberger, H., 2004: Practical Handbook of Meterial Flow Analysis. Lewis publishers, London, p. 1–318.

GIS, 1995: Rezultati ankete za zasebne lastnike gozdov – 1995. Gozdarski inštitut Slovenije, Ljubljana, unpublished.

GIS, 2002: Rezultati ankete lastnikov gozdov v občini Solčava. Gozdarski inštitut, Ljubljana, unpublished.

GIS, 2004a: Rezultati ankete o količinah lesnih ostankov v Sloveniji. Gozdarski inštitut Slovenije, Ljubljana, unpublished.

GIS, 2004b: Rezultati ankete proizvajalcev lesne biomase. Gozdarski inštitut Slovenije, Ljubljana, unpublished.

Hashimoto, S., Moriguchi, Y., 2004: Data book: material and carbon flow of harvested wood in Japan. Center for Global Environmental Research: National Institute for Environmental Studies, Tsukuba (CGER; D034–2004).

Hekkert, M. P., Joosten, L. A. J., Worrell, E., 2000: Analysis of the Paper and Wood Flow in The Netherlands. Resources, Conservation and Recycling 30(1): 29–48.

ICP, 2006: Podatki o porabi lesa za proizvodnjo celuloze in vlaknin. Inštitut za celulozo in papir, Ljubljana, unpublished.

INTERNOVA, 2006: Baza podatkov o žagarskih obratih 2002. Internova d.o.o. Ljubljana, unpublished.

Jensen, A. A., Hoffman, L., Moller, B. T., Schmidt, A., Christiansen, K., Elkington, J., 1997: Life Cycle Assessment: a guide to approaches, experiences and information sources. European Environment Agency, p. 1–104.

Krajnc, N., Piškur, M. 2006: Tokovi okroglega lesa in lesnih ostankov v Sloveniji. ZbGL 80: 31–54.

Medved, M., 2005: Pomen statističnih raziskav za spremljanje gospodarjenje z zasebnimi družinskimi gozdovi v Sloveniji. V: Tkačik, Boris (ur.), Urbas, Marina (ur.). 15. statistični dnevi, Radenci, 7. – 9. november 2005. *Komuniciranje z dajalci in uporabniki statističnih podatkov ter podpora EMU in Lizbonski strategiji: zbornik: proceedings volume.* Ljubljana: Statistični urad Republike Slovenije: Statistično društvo Slovenije: = Statistical Office of the Republic of Slovenia: Statistical Society of Slovenia, p. 309–320.

Palmer, C. E., 2000: The extent and causes of illegal logging: an analysis of a major cause of tropical deforestation in Indonesia. CSERGE, London, p. 1–33.

Piškur, M., 2005: Možnosti sledenja certificiranega lesa v Sloveniji. Magistrsko delo. Ljubljana, samozaložba p. 1–122.

SURS, 2000: Popis kmetijskih gospodarstev: POPIS-KME/10L. Statistični urad RS, Ljubljana, unpublished.

SURS, 2003: Raziskovanje strukture kmetijskih gospodarstev: KME-JUNSTRK/3L. junij 2003, Statistični urad RS, Ljubljana, unpublished.

SURS, 2005: žRezultati ankete KME-JUNSTRK/3L za leto 2005'. Ljubljana, Statistični urad RS, unpublished.

SURS, 2006a: Rezultati ankete APG 2004. Statistični urad RS, Ljubljana, unpublished.

SURS, 2006b: Rezultati ankete APEGG 2002 . Statistični urad RS, Ljubljana, unpublished.

SURS, 2006c: Banka statističnih podatkov. <http://bsp1h.gov.si/D2300.kom/komstart.html> (15. 5. 2006)

Veselič, Ž., 2004: Illegal logging in Slovenia. Joint UNECE/FAO Workshop on Illegal Logging and Trade of Illegally-derived Forest Products in the UNECE Region Palais des Nations, UNECE/FAO, Geneva, p. 1–9.

ZGS, 2005: Končno poročilo projekta: Preskrba in raba bioenergije ob sočasnem zagotavljanju trajnostnega gospodarjenja z gozdom. Zavod za gozdove Slovenije, Ljubljana, p. 1–185.

ZGS, 2006: Rezultati ankete o žagarskih obratih v Sloveniji. Zavod za gozdove Slovenije, Ljubljana, unpublished.

Sažetak

Raščlamba tokova drva u Sloveniji

Za strateško razvojno planiranje u djelatnostima vezanima uz drvo potrebne su raščlambe tokova drva. Istraživanja tokova drva omogućuju pregled trenutačne situacije i služe kao podloga za sve odluke koje se donose, a odnose se na razvoj šumarstva i sektora prerade drva. U prošlih dvadeset godina drvne bilance i raščlambe tokova izrađene su za brojne zemlje, koje služe kao osnova za planiranje razvoja ili kao podloga za procjenu ilegalnih sječa u šumama. Strateško planiranje razvoja gospodarskih grana vezanih uz drvo zahtijeva informaciju o tokovima drvne sirovine u proizvodnom lancu.

Raščlambom toka drva utvrđena je bilanca između proizvodnje i primarne preradbe drva u Sloveniji. Dobiveni odnosi pokazuju povezanost obiju djelatnosti, kakvoće i dostupnosti podataka, bilance uvoza i izvoza, te upućuju na značenje drva u domaćoj potrošnji.

Sukladno pripremljenomu modelu i ciljevima istraživanja izrađene su dvije bilance. Rezultati su predstavljeni u djelomičnim okvirima tokova drva u Sloveniji, gdje su okviri u međusobnoj interakciji nadopunjavajući jedan drugoga sukladno njihovu značenju. Krajnji je i najvažniji rezultat predstavljanje obiju inačica bilance obloga drva u Sloveniji: službene bilance obloga drva i oblikovane bilance obloga drva.

Značajne su razlike uočene između službene i oblikovane bilance. U službenoj drvnoj bilanci Republike Slovenije nedostaje više od 500 000 m³ (neto godišnje). Najveći se manjak odnosi na ogrjevno drvo (više od 270 000 m³) te pilansko oblo drvo (više od 185 000 m³). Postojeći podaci o potrošnji ogrjevnoga drva razmjerno su stabilni, što pokazuje da je neto etat ogrjevnoga drva po službenim podacima nedovoljan (750 000 m³).

Ako se razmatra oblikovana drvna bilanca, neto je etat povećan s obzirom na procjenu. U tom je slučaju bilanca pozitivna. Proizvodni je višak iznad registrirane potrošnje od 55 100 m³, što je manje nego 2 % cjelokupnoga neto etata. Pretpostavka je da je podcijenjena količina drva iskorištena u velikim energetskim sustavima. Potrošnja ogrjevnoga drva u domaćinstvima također je vrlo umanjena u modelu. Osim toga pretpostavka je da je procijenjena količina izvezenoga obloga drva, koje potječe iz privatnih šuma, ustvari veća te da nije u potpunosti registrirana u

bazama podataka. Zbog navedenih pretpostavki stajalište je da je oblikovana drvna bilanca bliža stvarnoj situaciji s obzirom na proizvodnju i potrošnju drva nego službena drvna bilanca.

Imajući na umu da je visoka kakvoća podataka veoma važna za izradu drvne bilance, kakvoća i dostupnost podataka trebale bi biti poboljšane u idućim godinama. Nadalje, drvne bi se bilance trebale izrađivati svake godine. Potrebno je osigurati stalnu i vrsnu procjenu trenutačnoga stanja. Dugoročno gledano, moći će se predvidjeti trendovi budućega razvoja u granama gospodarstva blisko vezanima uz šume i drvo.

Authors' address – *Adresa autorâ*:

Mitja Piškur, MSc.
e-mail: mitja.piskur@gozdis.si
Nike Krajnc, PhD.
e-mail: nike.krajnc@gozdis.si
Slovenian Forestry Institute
Department of Forest Technique and Economics
Večna pot 2
1000 Ljubljana
SLOVENIA