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Aspects of forest resource data availability and system functionality

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ABSTRACT

Being a large home products retailer IKEA uses around six and a half million cubic meters of wood annually in its products. IKEA has a wide range of suppliers in many countries all around the world. In 2007 IKEA launched a project introducing GIS into the company's wood sourcing system. The present study was conducted during the summer and autumn of 2007 in collaboration with IKEA. Its aim was to investigate issues that had arisen in the course of the GIS project in the company, such as region of origin in wood tracing, availability of forest resource data on sub-country regional level. In addition, this study is to provide an insight into the systems future usage by building a sample database and testing essential functionality of the system by the means of ArcView 9.2 GIS software.

A few examples of GIS in wood origin tracing and decision support systems in other companies were reviewed. Information on territorial divisions in place was collected for twelve countries selected for the study in order to investigate the wood origin region definition issue. The selected countries were: Sweden, Finland, Estonia, Latvia, Lithuania, Belarus, Poland, Ukraine, Czech Republic, Slovakia, Romania and Bulgaria. In the next step, availability of forest resource data at the defined sub-country regional level was assessed for the same set of countries. Finally a sample database was built including IKEA's forest tracing system data, acquired forest resource data for a sub-set of countries and spatial data for displaying features of countries, regions and sub-regions on the map. With the sample database and the GIS software programme, ArcView 9.2, practical execution of a few principal tasks was tested.

Results revealed a pattern of multi-purpose territorial units in the countries covered by the study and possible approaches to the wood origin region definition issue. Furthermore, the results showed a limited availability of forest resource data on a sub-country regional level in the investigated countries. However, it is important to point out that the study presents just a "snap-shot" picture as of 2007. The final part allowed for identifying basic relationships in the database which were necessary for the software to execute principal data query and analysis tasks as well as allowing for obtaining a picture of the visualization capabilities of the system.

A few recommendations were given concerning wood origin region definition and the outlook of including forest resource data in the GIS system in IKEA's wood sourcing.

Keywords: GIS, IKEA, wood sourcing, wood origin tracing, forest tracing system, forest resources data, territorial unit, region.

1. INTRODUCTION

IKEA is a privately held, international home products retailer. IKEA sells a variety of low price products including furniture, accessories, and bathroom and kitchen furnishings at retail stores around the world. While IKEA's core business is to sell home furnishings, they also develop and purchase IKEA products in relationship with suppliers. The IKEA Group has operations in 44 countries, 45 trading service offices in 31 countries, 1 300 suppliers in 54 countries, 26 distribution centres and 10 customer distribution centres in 16 countries. IKEA Group sales in 2006 were 17, 3 billion Euros. IKEA widely uses wood in their products; it is the principal material in many of the home furnishing. Total wood volume used in IKEA products in 2006 was 6, 4 mill m^3 (IKEA, Social Responsibility Report 2006).
IKEA's suppliers of wood products are spread all around the world. IKEA's top five wood sourcing countries according to the Social Responsibility Report (2006) are:

- Russia
- Poland
- China
- Romania
- Sweden

The top five tree species used in IKEA products according to the Social Responsibility Report (2006) are:

- Pine sp. - 42%
- Birch sp.- 18%
- Spruce/Fir sp. - 16%
- Beech sp. - 10%
- Oak sp. - 3 %

In the last decades, the forest sector has been facing many new challenges. Paradigmatic changes have happened to the forest policy on a global scale. The rising general concern about the unsustainable use of forest resources, illegal logging with spreading deforestation, desertification and threats to biodiversity resulted in creation of different forest certification systems. The most widely recognized certification system is the FSC (Forest Stewardship Council) certification scheme; it is followed by PEFC (Programme for the Endorsement of Forest Certification schemes), SFI (Sustainable Forest Initiative) and others. Over the past 13 years (1994-2007), over 90 million hectares in more than 70 countries have been certified according to FSC standards (About FSC, http://www.fsc.org/en/about). To enable the buyer to distinguish wood coming from certified forest certification schemes, they have been extended into the wood supply chain and CoC (Chain of Custody) certification standards have been introduced. Only a portion of the forests have been certified so far and not all wood processing industries benefit from chain of custody certificates.
As long as none of the credible third party certification schemes apply the risk of such issues as illegal logging and threats to biodiversity, compliance with regional, national and international legislation persists. Therefore, wood sources must be evaluated by the wood purchasing company at the end of the supply chain.

In this context, major forest companies and forest industries all over the world committed themselves to ensure that the wood they use is coming from legal sources. In order to fulfil that request, it is necessary to be aware of the source where the wood originates.

For wood importers, it is uncertain that the wood they are importing meets the necessary requirements, without having a chain of custody systems. There are three main options for timber importers to ensure that the imported wood has been sourced legally (Dennis P. Dykstra et al., 2003):
1. To conduct their own audit of wood sources.
2. To purchase wood that has been certified as coming from sustainably managed forests and for which the chain of custody to the point of importation can be verified.
3. To purchase wood that has been certified throughout the entire chain of custody.

IKEA's long term goal is to source all wood in the IKEA range from forests that have been certified according to a forest management standard recognized by IKEA. IKEA uses the "staircase model" with their wood suppliers (Figure 1) in order to stepwise increase the demands (IKEA's position on forestry, 2006 and IKEA Social Responsibility Report, 2006).

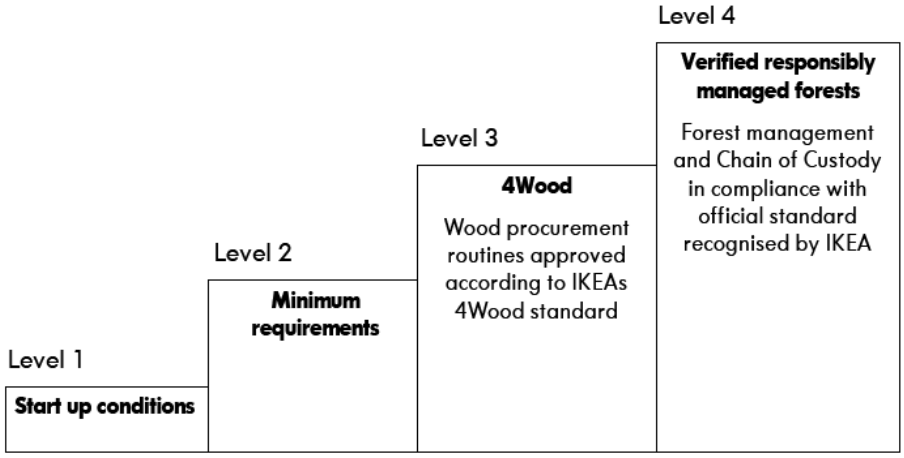

Figure 1. IKEA's staircase model (IKEA's position on forestry, 2006)

The staircase levels according to IKEA's Social and Environmental Responsibility Report 2006 are as follows:

Level 1: Start-up conditions. This level has basic requirements that wood product suppliers must fulfil before starting up their business with IKEA. The origin of the wood must be known. The supplier must be able to state from which region within a country that the wood originates. The wood must not originate from intact natural forests (INF) or high conservation value forests (HCVF) High value tropical tree species must be certified according to the Forest Stewardship Council (FSC).

Level 2: Minimum requirements. At Level 2 there are a number of minimum requirements that suppliers must fulfil. The wood must be produced in accordance with national and regional forest legislation and other applicable laws. The wood must not originate from protected areas. The wood must not originate from plantations in the tropical and subtropical regions established after November 1994 by replacing intact natural forests.

Level 3: 4Wood to ease transition. 4Wood is a standard that was developed for suppliers by IKEA in 2005 to ease the transition from Level 2 to Level 4. The 4Wood standard emphasises the use of wood-tracking procedures and other routines to better control wood from procurement through production.

Level 4: Forests certified as responsibly managed. The expectation at Level 4 is that forest management and chain of custody standards must be produced in a balanced cooperation between social, environmental and economic stakeholders and verified by an independent third party. Currently, Forest Stewardship Council is the only Level 4 certification scheme recognised by IKEA.

IKEA's short term goal for 2009 is to ensure that all suppliers meet the level 2 standards in the staircase model and to have 30 % of wood certified according to the level 4 standards.
IKEA is also actively involved in forest projects in their prioritized wood sourcing regions focusing on critical issues such as combating illegal logging, promoting forest certification, and training and education on responsible forest management.
IKEA has twelve foresters working in different locations around the world to support and encourage a more sustainable approach to the use of forest and wood resources. The foresters work together with IKEA business teams to implement and follow up IKEA supplier compliance with forestry minimum requirements (IKEA Social Responsibility Report, 2006).

Collection of the information about wood origin, volumes and species by the means of annual questionnaires forms the basis of IKEA's Forest Tracing System (FTS). The information from the FTS questionnaires is checked by IKEA's foresters and purchasing teams. After performing risk analysis, some supply chains are chosen for audit. Suppliers' and sub-suppliers' wood supply is audited from factories to the forest. The wood supply chain audit may be conducted by an IKEA forester or an independent auditor. In 2006, 90 wood supply chain audits were conducted. This represents a volume of 2.1 million cubic metres of round wood logs, which equals 33 percent of the total wood used in IKEA products (IKEA Social Responsibility Report, 2006).

In 2007, IKEA started a project aimed at introducing GIS for supporting the company's wood sourcing. Prior to 2007, there had not been a special tool to handle spatial data in IKEA's wood sourcing routines. However, the records of wood origin and the data on locations of performed field audits are geographic data.

Geographic information system (GIS), also known as geographical information system or geospatial information system is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the Earth. In a more generic sense, GIS is a tool that allows users to create interactive queries (user created searches), analyze the spatial information, edit data, maps, and present the results of all these operations (GIS, available at http://en.wikipedia.org/wiki/GIS).In the strictest sense, it is an information system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically-referenced information.
GIS represents real world objects with digital data. There are two main types of data: vector and raster data. Raster data consists of rows and columns where each cell represents a certain value. Raster data is used to represent continuous fields, while vector data represents discrete objects. There are three main types of vector data: points, lines and polygons. Additional non-spatial data can also be stored. With vector data, the additional data are attributes of the object. For example, a forest inventory polygon may also have an identifier value and information about tree species.
Originally, up to the late 1990s, when GIS data was mostly based on large computers and used to maintain internal records, software was a stand-alone product. However, with increased access to the internet and networks, the demand for distributed geographic data grew. GIS software gradually changed its entire outlook to the delivery of data over a network (GIS, available at http://en.wikipedia.org/wiki/GIS).

According to Päivinnen and Köhl (2005) three basic elements of the GIS can be distinguished: (i) data collection and input, (ii) data storage and management, (iii) information retrieval. This structure is shown in Figure 2.

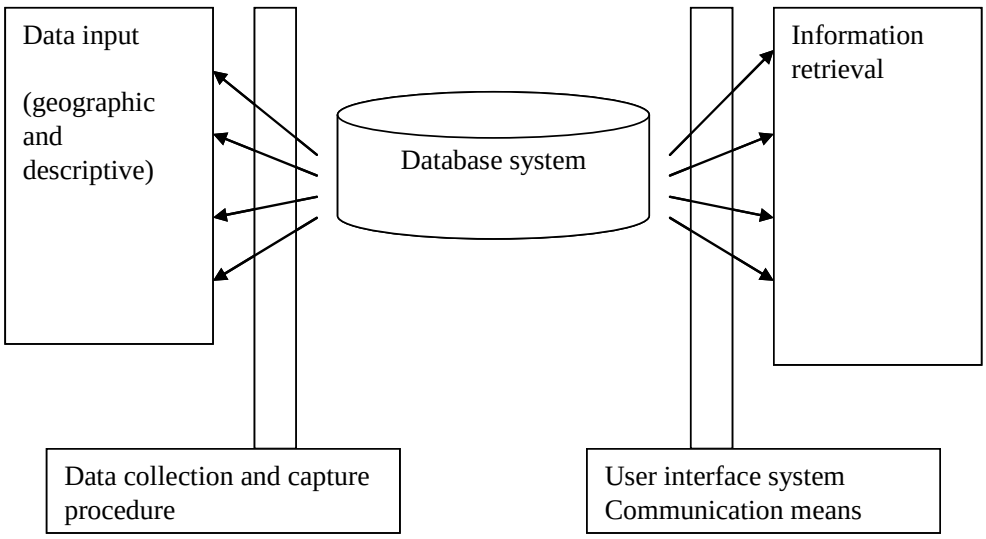

Figure 2. GIS basic components (Päivinnen, R., Köhl, M., 2005)

According to Päivinnen and Köhl (2005) there are two main types of input data: (i) geographic data: spatial geo-referenced elementary units which represent the whole studied area when aggregated (in the present study these are maps with boundaries of countries and regions); (ii) descriptive data: quantitative data which characterize spatial

elementary units (in the present study this is the IKEA Forest tracing system data and selected forest resource data). Data storage and management is ensured by special software, which allows for the capturing, storing, analyzing and retrieving of the data. Usually it is a relational database system; however, geographic data requires special functions.
Users interact with the database by the means of an interface system. Päivinnen and Köhl (2005) highlight the following functions of the interface systems: (i) user identification: normal, privileged etc; (ii) user-friendly navigation tool for quick data access. The information exchange between users and the database must be ensured by appropriate communication means.

GIS application in relation to IKEA is supposed to connect wood sourcing data to digital maps through declared wood origin regions. It has to be pointed out that what is being introduced is an information management, analysis and decision support tool to support the implementation of IKEA's wood sourcing policy. However, it is not, at least at the present stage of development, a tool for steering or optimizing wood flows on the operative level. Since there are different groups of potential users located in different places around the world the system must be web accessible with multi-level access corresponding to the needs of respective user group. Thus, the internet would play a crucial role in the implementation of the whole system.

This study addresses several issues which have surfaced in the course of the GIS project with IKEA.
The first issue is related to the origin tracing of the wood used in IKEA products. Handling data about wood origin is seen as one of the principal tasks for GIS. The term "wood origin" can be understood very differently depending on the context and scale of reference: single tree, forest stand, region, country and perhaps even a continent. However, in wood supplies it is commonly understood as the harvesting site where the wood was removed. The reason is that in most countries forest management activities such as harvesting are documented including harvesting site location and therefore possible to verify.

As GIS is supposed to operate on the top level where all the lines of the wood supply web eventually meet, the data fed into the system will not be on such fine scale. Documentation and control of every single supply chain up to the harvesting site is every supplier's responsibility; compliance with the latter being one of the principal preconditions for a supplier to work with IKEA in line with the staircase model. A system of supply chain audits carried out by IKEA helps to verify fulfilment of the requirements. Thus, in the company's forest tracing system IKEA refers to larger territorial entities as wood origin regions. In most cases these are entities of countries administrative territorial division. Suppliers must refer to these regions when submitting reports on the origin of the wood used for the supplied product. It is, however, not obvious what the optimal scale of such reference units should be and how to deal with the differences between countries. This study is aimed to critically examine IKEA forest tracing territorial reference units for selected countries with regard to aspects of average size, variation of size within and

between countries, status and function of the concerned territorial division in given country.

The second issue is concerned with the availability of forest resource data at the regional level which, combined with forest tracing system data (see above) in the GIS, could be used in the company's wood procurement planning. The need of forest related information for various interest groups was investigated by the EFI (European Forest Institute) in the European Forest Information and Communication System study, 1997. The study was conducted using a questionnaire. Respondents had to assess how information about forest resources in other countries was important for their organization. The study showed that information on wood resources was very important or important for 83% of the respondents. Results by interest groups showed that the forest industry is mainly interested in the volume of the annual cut, timber quality and the volume of the annual increment. Information on the country level was found more important than on the regional level. However, the interest in the information on the regional level increased when larger countries with big variation in growth regions were concerned.

Better information on the region's forest resources could help IKEA in evaluating potential suppliers and the region's potential to provide raw materials for certain wood products. An assessment of suppliers' capacities versus resources available in the region helps to avoid undesired competitions for wood resources between their own suppliers. As a result, this could cause a rise in prices. However, such information might be difficult to obtain, especially in a foreign country, without knowing the organization of the forest sector and the forest information system. Therefore, the availability and accessibility of this data was investigated in the selected countries in relation to the regions of reference for wood origin tracing.

The third issue deals with some of the practical tasks set for the system. The functionality of the software can only be realized if the input data is consistent with its technical features. The basic relations between the data, that are needed to enable the software to execute the basic tasks, were investigated and tested.

In conclusion, it can be noted that the initiative to conduct this work came from the company and speaks for the relevance of the study. However, it is also true that as a result this study does not focus deeply on a certain scientific discipline but touches on several disciplines with the development project in IKEA as the uniting factor. The thematic focus of this study is at the intersection point of GIS, corporate policy and wood procurement planning.

1.1. Aim of the study

The aim of the study is to investigate the aspects of data availability and system functionality with regard to the introduction of GIS into IKEA's wood sourcing system.

The tasks relating to the overall aim of the study are:

- Review examples of GIS in wood origin tracing in other companies.
- Examine the existing territorial division of twelve selected countries from the wood origin tracing perspective. The selected countries are: Bulgaria, Romania, Estonia, Latvia, Lithuania, Finland, Sweden, Czech Republic, Slovakia, Poland, Ukraine and Belarus.
- Assess the availability of selected forest resource data on relevant regional levels for the selected countries.
- Define principal structural features of a geodatabase suitable for including and interlinking map data, IKEA's wood sourcing data and selected forest resource data so as to ensure relevant visualization and analysis functionality of the GIS software Arc View 9.2. Build a sample database including named elements.
- Test relevant system functionality using ArcView 9.2 software and the sample database.

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2. MATERIALS AND METHODS

Information about comparable applications of GIS in other wood and forest sector companies was researched primarily via the internet. The information was found on companies' home pages, various project reports and similar sources. The three most comparable examples were selected for closer examination of the tasks and working principles of the system.

The regional issue for wood origin tracing was approached using the patterns of existing multi-purpose and level territorial divisions with delimited boundaries for the selected countries. The average, minimum, and maximum values of a unit area (total and forested) were found and summarized for each type of territorial division. The quantitative and certain qualitative features of the examined territorial division patterns that could have relevance for wood origin tracing were noted. The types of information sources that were mainly used were: web-based encyclopaedias, releases of national institutions for statistics, websites of national forest administrations of the respective countries. Considering different aspects of wood origin tracing, several criteria were formulated for evaluation of the possible wood origin reference regions. The identified territorial division patterns were evaluated following the criteria.

In the second part of the study international and national forest related information sources were examined in order to assess the availability of forest resource data for the regional (sub-country) level. The international information sources were internet accessible databases, e.g. the one maintained by FAO. National information sources were studied in two ways. First, published information sources, such as forest statistical yearbooks and annual reports on forests were identified and examined. These publications give a reference to the actual source, i.e. the organization producing forest resource data in given country. Secondly, the national organizations that maintain national forest databases were contacted directly. Requests were sent to these national organizations via e-mail and were supplemented by oral communication via the phone when necessary.

Spatial data used as an input for the sample database in the third part of the study comprised three polygon feature classes: countries, regions and districts according to the IKEA forest tracing system. In addition, data from the IKEA forest tracing system's last survey on wood supplies and acquired forest resource data for a few selected countries was used as attributes in the sample data base.

Data in the Countries' feature class allows for the displaying of country boundaries. It contains the attribute fields listed in Table 1.

Table1: Attributes of the Countries' feature class

Countries' feature class	
Object ID	Automatically assigned
Shape	Automatically assigned
ID	Consists of two first letters of the country name
Name	Name of the country
Usedbyikea	Shows whether IKEA has any activities in a given country. The field is confined to the domain yes/no.
Shape length	Automatically assigned
Shape area	Automatically assigned

Regions' feature class is needed to display the boundaries of wood origin regions defined by IKEA. Regions serve as wood origin reference in most of the countries. The attributes of the Regions' feature classes is listed in Table 2.

Table 2: Attributes of the Regions' feature class

Regions' feature class	
Object ID	Automatically assigned
Shape	Automatically assigned
ID	Consists of country code and three (usually first) letters of the region name or country code and numeric value.
Name	Name of the region
CountryID	The same as ID field in the country feature class
Shape length	Automatically assigned
Shape area	Automatically assigned

Districts' feature class covers only those countries where IKEA applies the division in addition to the regions. The attributes of the Districts' feature class are listed in Table 3.

Table 3: Attributes of the Districts' feature classes

Districts' feature classes	
Object ID	Automatically assigned
Shape	Automatically assigned
ID	Consists of combination of letters including country code and numeric value
Name	Name of the subregion
Shape length	Automatically assigned
Shape area	Automatically assigned

All spatial data was referenced to the WSG1984 coordinate system without a projected coordinate system.

The available forest resource data was compiled into a table and added as a non-spatial data table to the geo-database. The fields of the forest resource database are listed in Table 4.

Table 4: Fields of the Forest resource database table

Forest resource data	
Object ID	Automatically assigned
Country name	Name of the country
Country ID	The same as ID in the countries feature class
Region name	Name of the region
Region ID	The same as ID in the regions feature class
Gr st pine 01 20	Growing stock of pine by age classes in m^3
Gr st pine 21 40	
Gr st pine 41 60	
Gr st pine 61 80	
Gr st pine 81 100	
Gr st pine 101	
Growing stock pine	Total growing stock of pine in m^3
Gr st spruce 01 20	Growing stock of spruce by age classes in m^3
Gr st spruce 21 40	
Gr st spruce 41 60	
Gr st spruce 61 80	
Gr st spruce 81 100	
Gr st spruce 101	
Growing stock spruce	Total growing stock of spruce in m^3
Gr st conifers 01 20	Growing stock of all coniferous species by age classes in m^3
Gr st conifers 21 40	
Gr st conifers 41 60	
Gr st conifers 61 80	
Gr st conifers 81 100	
Gr st conifers 101	
Growing stock conifers	Total growing stock of all coniferous species in m^3
Gr st birch 01 20	Growing stock of birch by age classes in m^3
Gr st birch 21 40	
Gr st birch 41 60	
Gr st birch 61 80	
Gr st birch 81 100	
Growing stock birch	Total growing stock of birch in m^3
Gr st beech 01 20	Growing stock of beech by age classes in m^3
Gr st beech 21 40	
Gr st beech 41 60	
Gr st beech 61 80	
Gr st beech 81 100	
Gr st beech 101	
Growing stock beech	Total growing stock of beech in m^3
Gr st oak 01 20	Growing stock of oak by age classes in m^3
Gr st oak 21 40	
Gr st oak 41 60	
Gr st oak 61 80	
Gr st oak 81 100	
Gr st oak 101	
Growing stock oak	Total growing stock of oak in m^3

Table 4cont.: Fields of the Forest resource database table

Gr st broadl 01 20	Growing stock of all broadleaved species by age classes in m^3
Gr st broadl 21 40	
Gr st broadl 41 60	
Gr st broadl 61 80	
Gr st broadl 81 100	
Gr st broadl 101	
Growing stock broadleaves	Total growing stock of all broadleaved species in m^3
Growing stock all species	Total growing stock of all species in m^3
Actual cut pine	Annual cut of pine in m^3 (data of the last year or up to two years back)
Actual cut spruce	Annual cut of spruce in m^3
Actual cut conifers	Annual cut of all coniferous tree species in m^3
Actual cut birch	Annual cut of birch in m^3
Actual cut beech	Annual cut of beech in m^3
Actual cut oak	Annual cut of oak in m^3
Actual cut other broadl	Annual cut of all other broadleaved tree species apart from birch, beech and oak in m^3
Actual cut broadleaves	Annual cut of all broadleaved tree species in m^3
Actual cut all species	Annual cut of all tree species in m^3

The data from IKEA's Forest tracing system were also added as non-spatial data table. The fields of the wood supply database are listed in Table 5.

Table 5: Fields of the wood supply database table

Wood supply data	
OBJECTID	Automatically assigned
TA	IKEA's Trading Area
SupplierNumber	Unique numeric value assigned to every supplier by IKEA
SupplierName	Name of the supplier company
SubSupplierName	Name of the subsupplier company
SubSupplierType	Numeric code representing the type of subsupplier
MaterialType	Numeric code representing the type of material
SpeciesName	Numeric code representing the tree species
SpeciesLatinName	Species Latin name, mandatory only when other then ordinary species used
WoodCountry	ID code of the wood origin country
WoodRegion	ID code of the wood origin region
WoodSubregion	ID code of the wood origin subregion
Volumen	Volume of the supplied wood products in m^3
RWEConvFact	Conversion factor to the roundwood equivalent
IKEAVolumnRWE	Wood volume in roundwood equivalent in m^3
IKEADemand	Represents if IKEA's requirements on wood supply has been met. Confined to yes/no values
FSCVolumen	Share of the FSC certified wood in supplied volume
FSCCertificate	Number of the FSC certificate

The GIS software package, ArcView 9.2, was used for building the sample database and working with the data. The data in the sample database was interconnected so as to enable the desired data query and analysis functions.

3. RESULTS

3.1. Examples of GIS applications in wood origin tracing

Most legitimate timber companies implement some type of log-tracking system. Initially, motivation for the development of log-tracking systems was to prevent theft of logs or other wood products. More recently, companies have begun to realize that significant benefits can be achieved through careful management of logistical operations such as log transport. Sophisticated logistic systems enable supply managers to know where the certain batch of timber is at any given moment in time, i.e. when it is expected to arrive at the mill. Real-time information produces time and cost savings, reduces environmental impacts and helps supply the right quality raw materials to each mill. Another important reason for companies to implement wood origin tracing is that such arrangements are essential if the company wishes to obtain chain of custody certification (Dykstra *et al*, 2003). The sourcing policy of companies like IKEA motivates timber companies to seek chain of custody certification and implement wood tracking practices. Next a few examples of GIS supported wood tracing systems in some major forest companies that use large quantities of imported wood are discussed.

"Tracing Russian Wood Imports" (2001) is a project report issued by the UPM Kymmene and partner organizations. It describes the system used by UPM Kymmene for tracing wood imports. In 1996, UPM Kymmene became the first forestry company to start developing an information system for tracing the origin of wood. One of the main objectives was to create a system that could be utilized to communicate information about the group's timber procurement from Russia, and Russian forestry in general, to their staff, customers and other interested parties.
The system is built on three keystones: a statement of origin, a database and GIS mapping program and audits in the country of origin.

The statement of origin includes specification of the location of the harvesting site. In this case it implies indication of "subjects of Federation" and "leskhoz". "Subjects of Federation" are the self-governing regions constituting Russian Federation. "Leskhoz" was used as a basic forest management unit in Russia before the adoption of the new forest code.
The database contains information on suppliers and delivery contracts, information from statements of origin and information on audits. The UPM Kymmene's Tuonti GIS program provides detailed information about imported wood deliveries to be recorded, queried and displayed instantly on the screen. It can produce a variety of maps, charts or reports for management purposes. High quality maps can be produced at the user's desk or centrally on large digital plotters. The GIS is based on two maps: the base map which provides general information such as land, water, topography, built up areas, etc., and the function map which displays all regional boundaries, railway stations and audit locations.

Another major Finnish forest company, Metsalliito, requires all suppliers to indicate the wood origin. Collected information is entered into a general GIS-linked database. As a result, the data on the timber origin is linked to a digital map. Digital maps visualize

locations of harvesting sites. In addition digital maps display areas of nature protection. For wood tracking in Finland, Metsaliitto uses the contract number. Each timber purchase contract between Metsaliitto and the forest owner has a unique number, so the origin of each batch of timber entering the mill can be identified according to this number (Samarina, 2006; http//www.metsaliitto.com). There is no information in regards to which regional or management units Metsaliitto uses as a reference for indicating wood origin for timber imported from other countries.

Stora Enso's wood traceability system is based on similar principles as the two described above. Stora Enso requires suppliers to provide the following information: geographical and ownership data on harvesting area (e.g. land register numbers, forest management unit details, and GPS coordinates). The data on wood origin is stored in a general database, which comprises GIS maps, information on licenses and certificates, environmental data and logging output. (http//www.storaenso.com).
In 2003, Stora Enso adopted a GIS based European-wide forest resource information system. It serves as a support for strategic planning and wood procurement. The system can provide the company's wood supply managers with information on forest resources in Europe in an illustrative way, for example as thematic maps. With the map-based user interface, the user can view and produce reports, e.g. about production plants and wood flows. A variety of analysis functions produces new information, which supports strategic planning (GISnet supplies European-wide forest resource information system for Stora Enso, available at http://www.directionsmag.com/press.releases/index.php?duty=Show&id=7836&trv=1). However, there is no available information about which kind of forest resource data is included in this database and whether it contains data only at the country level or also at the regional units' level.

3.2. Wood origin regions in the IKEA forest tracing system

The "wood origin region" is defined in this study as a unit of a countries' territorial division that can be referenced by IKEA suppliers in their wood origin declarations. The territory might have an administrative status, or be a forest management unit.

When defining such wood origin regions, certain aspects of the regions need to be considered. First, these territories need to have clearly defined and identifiable boundaries so that there is no uncertainty in regards to each wood origin region. Secondly, the features of the chosen territorial division should facilitate implementation of IKEA's forestry related policy. Thirdly, information on the territory's forest resources should be distinguishable in accordance with the territory's boundaries.

The scale of territorial division or the size of territories or regions delimited by the given division also needs to be considered. In each country there are a few options to be considered: one or two levels of administrative division, a specific territorial division applied by a state forest administration or management organization. It is possible to define wood origin regions comprising of more than one real region. However, the choice might not be as obvious as it may seem. Small territories could significantly complicate wood origin reporting routines for suppliers and could adversely affect their willingness to collaborate without giving substantial improvements to the credibility of reporting. Furthermore, from the policy implementation point of view it would hinder the application of a reasonable risk assessment or risk-ranking to the wood origin regions. However, a finer scale of wood origin regions would give more flexibility in responding to issues like social conflicts and nature protection issues.
With regard to data management, the data would become more fragmented if the units were smaller. However, large territories would reduce the relevance of wood origin reporting and reduce its credibility. In some countries, usually with the domination of state owned forests, most of the forest data records are based on a specific territorial division according to the structure of the forest management organization and ignoring the countries general administrative territorial division. Therefore, suppliers might have difficulties separating wood flows with the latter division structure. It is more reasonable to base the wood origin regions on these specific territories connected to the forest management organization. In addition, it would be preferable to have the wood origin regions of comparable size in different countries for consistency purposes.

These considerations are difficult to translate in certain quantitative terms such as what the smallest or the largest acceptable area of a region or the acceptable difference between regions in terms of area.

3.2.1 Review of countries' territorial division

The selected types of territorial divisions for the twelve countries are shown in Table 6. The summary includes the average minimum and maximum values of the total forested area by country and by the type of territorial division. Cells with question marks means there was no data available.

The table reveals a large variation in the size of territories, both within one country's territorial division and between the units of the territorial division of different countries. The greatest variation in size of the administrative territorial units at the same level among the selected countries is seen in Sweden and Finland. The main reason for the various sizes of the administrative territorial units at the same level within one country is the distribution of country's human population. Administrative territories in densely populated areas are more compact than in the scarcely populated parts of the land. The average size of the administrative territories is correlated with the total size of the country. Thus, for example, the average size of an administrative district *(rajons)* in Latvia is 2,46 t. km^2, as opposed to 19,54 t.$km^{2,}$ which is the average size of, *vojvodship*, an administrative district in Poland.

Table 6: Selected types of territorial division for the selected countries with the average, minimum and maximum values of the forest land and total areas

Country	Unit of territorial division	Number	Total area, t.km^2			Forest land area, t.km^2		
			max	min	average	max	min	average
Bulgaria	Region (NUTS 2 – EU statistics)	6	27,52	10,29	**18,50**	?	?	**5,37**
	Province (*oblast)*	28	7,62	2,05	**4,08**	?	?	**1,18**
	Regional Department of Forests	16	?	?	**6,93**	3,95	1,46	**2,11**
Romania	Development region (NUTS 2 – EU statistics)	8	36,85	29,21	**33,80**	12,82	5,73	**9,65**
	County (*judete*)/ Regional Forest Directorate	41	8,70	3,53	**5,89**	4,54	0,22	**1,69**
Estonia	County	15	4,81	1,02	**2,90**	?	?	**1,47**
	Region (NUTS 3 – EU statistics)	5	15,80	3,36	**8,74**	?	?	**4,42**
Latvia	Administrative District	26	3,59	1,61	**2,46**	1,74	0,48	**1,13**
	Regional Forest District	12	8,28	2,60	**5,33**	4,28	1,36	**2,46**
	Region (NUTS 3 – EU Statistics)	4	19,70	13,49	**15,98**	10,15	5,16	**7,37**
Lithuania	County	10	9,76	4,35	**6,53**	4,08	1,73	**2,21**
	State Forest Enterprise	42	?	?	**1,55**	0,86	0,18	**0,50**
Finland	Province (*län*)	6	98,95	34,38	**62,65**	50,06	17,28	**40,55**
	Region (*landskap*)	20	98,95	2,82	**16,85**	50,06	1,59	**10,67**
Sweden	Region (*land*)	4	153,31	79,91	**102,56**	68,18	49,99	**57,22**
	County (*län*)	21	98,61	2,96	**20,36**	36,16	1,82	**11,38**
	"*Riksområden*" (NUTS 2 – EU statistics)	8	153,30	14,00	**57,73**	68,19	5,35	**32,34**
Czech Republic	Region (*kraj*)	13	11,02	3,16	**6,03**	3,76	1,33	**2,03**
	Region (NUTS 2 – EU statistics)	8	18,08	6,48	**12,12**	6,75	2,06	**4,02**
Slovakia	Region (kraj)	8	9,46	2,05	**6,13**	4,62	0,65	**2,51**
	Regions (*zoskupenia krajov*) (NUTS2– EU stat.)	4	16,24	2,05	**12,26**	8,39	0,75	**5,01**
	Regional Forest Enterprise (*Odštepné závody*)	32	?	?	**1,53**	?	?	**0,63**
Poland	Voivodeship	16	35,60	9,41	**19,54**	7,97	2,48	**5,62**
	Regional Forest Directorate	17	?	?	**18,39**	6,40	1,71	**4,47**
Belarus	Province (*oblast*)/ Regional Forest Enterprise	6	40,40	25,00	**34,57**	?	?	**15,58**
	Forest Enterprise	96	?	?	**2,16**	?	?	**0,97**
Ukraine	Province (*oblast*)/ Regional Forest Directorate	24	33,31	8,10	**23,99**	?	?	**3,76**

Bulgaria

Area – 112, 9 t. km^2
Forest cover - 29%

The basic administrative unit of Bulgaria is a province (*oblast* in Bulgarian). The country is divided into 28 provinces and each province includes several municipalities. Municipalities are not considered in this study. The average area of a Bulgarian province is 4, 08 $t.km^2$, when not including the province of the capital city, Sofia. The average forest area per province is 1, 18 $t.km^2$. The Bulgarian National Forest Agency, which assures management functions in state forests and control functions in private forests, is composed of 16 Regional Forest Directorates (or Departments of Forest) covering the whole territory of the country. The boundaries of the Regional Forest Directorates do not coincide with the boundaries of the provinces. The average land area covered by a Regional Forest Directorate is 6, 93 t.km2 and the average forest area is 2, 11 $t.km^2$. The last type of territorial unit included in the list is the NUTS 2 region[1]. These units have no administrative status in Bulgaria but exist for statistical purposes. There are six regions and each comprises of several provinces. The average land area of these regions is 18, 50 t. km^2 and the average forest area is 5, 37 t. km^2

Romania

Area – 238, 4 $t.km^2$
Forest cover - 27%

The basic administrative unit of Romania is a county. The country is divided in 42 counties. The average area of a Romanian county is 5,89 $t.km^2$ with an average forest area of 1,69 $t.km^2$ (capital city Bucharest and Ilfov counties were taken into account).
The National Forest Administration of Romania includes 41 Regional Forest Directorates. The boundaries of the Regional Forest Directorates match the boundaries of counties. However, the National Forest Administration ROMSILVA assures only the management of state forests while there is a significant share of privately owned forests.
Besides, there exists a division into 8 development regions. These regions have no administrative status but serve mainly for statistics, planning, special economical regimes and distribution of the EU funds. Average land area of these regions is 33,80 t. km^2, average forest area is 9,65 t. km^2 (capital city Bucharest-Ilfov region was not taken into account) .

[1] In the EU exists so called NUTS region classification (Nomenclature of Units of Territory for Statistics) with NUTS 1 to NUTS 3 levels. Usually these NUTS levels are attributed to the existing units of administrative division but if there is no corresponding level administrative unit NUTS regions are defined specifically.

Estonia

Area – 45, 2 t. km^2
Forest cover - 50, 5%

Estonia is divided into 15 counties. The average area of a county is 2, 90 $t.km^2$ and the average forest land area per county is 1, 47 $t.km^2$. State forests are managed by the State Forest Management Centre and are divided into five Forest Management Regions. Their boundaries, however, do not match with the boundaries of the administrative territories. Control over all forests is ensured by the Regional Boards of Environment. For the EU statistics, the country is divided in five other regions, each covering several counties. The average land area of these regions is 8, 74 $t.km^2$ and the average forest area is 4, 42 $t.km^2$.

Latvia

Area – 64, 6 t. km^2
Forest cover – 45 %

Latvia is divided into 26 administrative districts. The average area of an administrative district is 2, 46 t. km^2 and the average forest land area per district is 1, 13 t. km^2. In addition, Latvian constitution recognizes four distinct regions of historical and cultural character. However, this division has no administrative status and is mainly used in regional development planning and statistics. With the Riga District detached, these territories are designated also as NUTS 3 statistics regions for Latvia. The State Forest Service that ensures control and advisory functions over all forests, is divided into 11 regional forest districts (as of May 2008). Each regional forest district covers territories of one or several administrative districts. However, this organization has been subject to frequent reorganizations and the number of districts might be changed again. The state enterprise, Latvian state forests, is responsible for the management of state owned forests has 8 regional offices, but other forests are not connected to this organization.

Lithuania

Area – 65, 2 t. km^2
Forest cover - 32, 5%

Lithuania is divided into ten counties. The average area of a county is 6, 53 t. km^2 and the average forest area is 2, 21 t. km^2. Lithuanian counties also serve as European NUTS 3 level statistical regions. State forest enterprises are managing the state-owned forests and ensuring control, advisory and policy implementation functions in private forests. Currently, there are 42 state forest enterprises. In the future, forest administration in Lithuania is likely to undergo reorganization, merging state forest enterprises. The average land area covered by a state forest enterprise is 1, 55 $t.km^2$ with an average forest area of 0, 50 $t.km^2$.

Finland

Area – 338,1 t. km^2
Forest cover – 86%

Finland is divided into six provinces. The average size of a province is 62, 65 t km^2 with an average forest land area of 40, 55 t.km^2. Lower level territorial units are regions referred to as *maakunta* in Finnish or *landskap* in Swedish. There are 20 such regions and the average area of a region (Åland not included) is 16, 85 t. km^2 with an average forest area of 10, 67 t.km^2. There is a huge difference in the size of the Northern provinces and regions compared to the Southern provinces and regions. In addition, there are 77 sub-regions referred as *seutukunta* in Finnish *or ekonomisk region* in Swedish. There are also five NUTS 2 regions for the EU statistics but they are not further considered since they are same scale as the provinces. Finnish forest statistics are presented by 13 regional forestry centres which are supervised by the Ministry of Agriculture and Forestry and whose task is promoting forestry and enforcing forest legislation locally. Territories of the regional forestry centres do not match with the units of countries administrative division.

Sweden

Area – 449, 9 t. km^2
Forest cover - 60 %

The basic administrative unit of Sweden is a county. The country is divided into 21 counties. The average area of a county is 20, 36 t.km^2 with an average forest area of 11, 38 t. km^2. In addition, there is a traditional division in four (sometimes three) regions or lands referred to, in Swedish, as *Norra Norrland*, *Södra Norrland*, *Sveland* and *Götaland.* These regions have no administrative function but are used in reference to statistics, and weather reports. Also, eight NUTS 2 level regions are defined for the EU statistics. They are referred to as National Areas or *Riksområden* in Swedish.

Czech Republic

Area – 78, 8 t. km^2
Forest cover – 33, 6%

Since 2000, the Czech Republic has been divided into 13 regions, referred to as *kraj* in the Czech language, and the capital city of Prague. The average land area of a region is 6, 03 t. km^2 with an average forest area about 2 t. km^2. The older division of 73 districts is also still recognized and they serve as seats for some branches of the state administration. The old district division are not considered for this study. For the EU statistics, there are eight defined NUTS 2 level regions, each of comprising of one or several regions. The average area of these regions is 12, 12 t.km^2 with an average forest area of 4, 02 t.km^2. The management of state owned forests is carried out by the state enterprise, Forests of the Czech Republic, and includes 13 regional forest directorates (*Krajský inspektorát*) matching up in boundaries with the administrative regions.

Slovakia

Area – 49,037 t. km^2
Forest cover – 40%

Slovakia or Slovak Republic is divided into eight regions referred to as *kraj* in Slovak. The average area of a region is 6, 13 t. km^2 with an average forest area of 2, 51 t. km^2. Like in other EU countries, the NUTS 2 level regions are adopted for statistics, making up four larger regions under the same names as the four regions that existed before the political changes of the beginning of 1990's but with different boundaries. State forest administration includes 32 Regional Enterprises, subjected to the General Directorate. The average territory corresponding to a regional forest enterprise is 1, 53 t. km^2 with an average forest area of 0, 63 t.km^2.

Poland

Area – 312, 68 km^2 t. km^2
Forest cover – 30%

Poland is divided into 16 regions or *voivodship*, in Polish. The average area of a region is about 19, 54 t. km^2 with an average forest area of 5, 62 t. km^2.
For EU statistics, there is a division into larger regions but these regions are not considered for this study. The state forest administration plays a dominant role in Poland. The territory of the country is covered by 17 regional forest directorates with boundaries not matching *voivodships*. Most forestry records and statistics are based on forest directorates. The average area of a regional forest directorate is 18, 39 t.km^2 with an average forest area of 4, 47 t.km^2.

Ukraine

Area – 603, 70 t. km^2
Forest cover – 16 %

Ukraine is divided into 24 provinces referred to as *oblasts* in Ukrainian and one Autonomous Republic, Crimea. The average area of a province is about 24 t. km^2 with an average forest area of 3, 76 t. km^2. However, Ukraine represents a special case in the sense of a very uneven distribution of forest cover over the country's territory. In fact only few provinces possess significant forest resources. All forests in Ukraine are state owned but are managed by different institutions. About 70% of forests are managed by the Ukrainian State Committee of Forestry (USCF) that is a part of the Ukrainian Ministry of Ecology and Natural Resources. Since 2004, regional forest directorates, one for each province, serve as the Committee's regional bodies. The 306 State Forest Enterprises carry out forest management activities under coordination with the Regional Forest Enterprises. Forest administration institutions in Ukraine are subject to frequent restructuring in the context of an unstable political situation.

Belarus

Area – 207, 60 t. km²
Forest cover – 45 %

Belarus is divided into six provinces referred in Byelorussian as *voblast*. The average area of a province is 34, 57 t. km^2 with an average forest area of 15, 58 t. km^2. Provinces are divided into 118 administrative districts. All forests in Belarus are state owned. More than 85 % of the forests are managed by the Ministry of Forestry. The structure of the Ministry includes six regional forest enterprises, one for each province, and 96 forest enterprises. The boundaries of the forest enterprises do not match administrative districts. The average territory corresponding to a forest enterprise is 2, 16 t.km^2 with an average forest area of 0, 97 t.km^2.

3.3. Availability of forest resource data at regional level

3.3.1. Selected records

In the short term, data on harvested wood volumes is the most relevant information from the wood procurement point of view. This data should be specified by tree species or by tree species groups (e.g. hardwood/ softwood). Statistics on wood removals by assortment (i.e. saw logs, pulpwood, veneer logs etc) would provide a better understanding of the available resource base. In the long term, the data on growing stock is also relevant. Information on the growing stock by species allows for the specification of regions with the greatest (or the least) stock of the species of interest. Forest age structure, i.e. growing stock by age classes, is a valuable input for long term planning.
In accordance with these considerations, the following records were selected for the assessment of availability:

- growing stock by region;
- growing stock by species and region;
- growing stock by species and age classes by region;
- actual cuttings by region;
- actual cuttings by species by region;
- actual cuttings volumes by method, final felling/ thinning by region;
- removals by assortment by region.

Attributes are ranked by the number of parameters included. The attributes with fewer parameters can be derived from the attributes with more parameters. It is important to point out that for this study, the impact of differences in forest record definitions in different countries was not considered. It is known that there are certain discrepancies, for example, with the estimation of growing stock due to different minimum diameter values. However, these questions are not within the scope of this study. An additional type of data which can be valuable is the geographical and attribute data on protected forest areas. This, however, was also not included in the assessment.

3.3.2. International information sources

Presently there exist several internet accessible international forest databases that have interface and records in English. However, geographical coverage and range of included records differ among databases. Therefore, the location of the countries of interest has to be taken into account when looking for data. Most of the countries included in this study are EU member countries and more data is available for these countries than for Ukraine and Belarus.

There is a number of different international organizations that have forest related data, among them are international organizations for statistics, research institutions and networks, NGOs and different branches of executive power in the EU. A comprehensive review of such sources is given by a 2003 Pan-European overview of the International Institution and Networks “Where to find forest data” published by the Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 2003.

With regard to the indicators used in this study, three institutions have the most comprehensive databases on forest resources and forest products with a broad range of records: the Food and Agriculture Organization of the United Nations (FAO), the Statistical Office of the European Commission (Eurostat) and the European Forest Institute (EFI).

FAO

FAO is an agency of the United Nations and the lead agency in issues related to forestry. FAO's goal in forestry is to enhance human well-being by supporting member countries in the sustainable management of the world's trees and forests. Article I/1 of the Constitution mandates FAO to "collect, analyse, interpret and disseminate information relating to nutrition, food and agriculture". The Constitution specifies that the term 'agriculture' and its derivatives include fisheries, marine products, forestry and primary forestry products (Where to find forest data, 2003).
On FAO's website (http://www.fao.org) it is possible to review countries' forestry profiles which are based on the reports from Global Forest Resource Assessment (FRA 2005). The country forestry profiles include a number of indicators such as: growing stock and growing stock per species, also removals and forest products production. All data is only available on the country level. Regional units are not considered, thus, this source is not utilized for this study.

Eurostat

Eurostat is the Statistical Office of the European Commission. In the framework of the European Statistical System (ESS) and in collaboration with the national statistical institutes (NSIs), Eurostat produces comparable and harmonised statistics (Where to find forest data, 2003). The database of forestry statistics contains numerous attributes of data on forest resources and production of forest products for the EU members and EFTA countries from 1992. The newest data on forest resources originates from TBFRA 2000 (Temperate and Boreal Forest Resource Assessment 2000) and the data on production of forest products dates back to 2005 (as of Sept. 2007). However, all data is sonly available on the country level and therefore is not used in this study.

***EFISCEN** inventory database*

EFISCEN European Forest Resource Database was established as an extension of the EFI's Forest Scenario Modeling Project. In this project, a large scale matrix model, the 'European Forest Information Scenario Model' (EFISCEN), was used to project the development of Europe's forest resources under various scenarios (Where to find forest data, 2003) Input data is available for 32 European countries. The data for the database is mainly taken from the national inventories. Attributes in the EFISCEN databases are given by the forest type. According to EFISCEN, the forest type is defined as "the forest that can be distinguished according to region, owner class, structure, site class and tree species". In the EFISCEN database age class, area, total and mean volume, total annual increment and current annual increment can be retrieved for each forest type (http://www.efi.int/databases/efiscen/intro.php). Some

of the attributes selected for this study can be derived from the data available in the EFISCEN. It is, however, questionable how the category of forest type specified by tree species corresponds to the term of tree species as it is commonly used in statistics representing features such as growing stock. The list includes all the countries covered by this study except Ukraine. For each country, a little information on the underlying forest inventory, i.e. metadata, is given. A registration was required for getting access to the EFISCEN database. The summary assessment of the availability of the selected records is shown in Table 7. However, the data for most countries is rather old, so it is assumed that data for growing stock older than 5 years should be regarded as outdated and badly suitable for a basis for planning.

Table 7: Availability of forest resource data at regional units' level in the EFISCEN inventory database

Country		Growing stock			Cuttings				Year of inventory
		Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
BG	country	**x**	**x**	**x**	---	---	---	---	2000
	Regional Dep. of Forests	---	---	---	---	---	---	---	
	Province	---	---	---	---	---	---	---	
	Specific region	**x**	**x**	**x**	---	---	---	---	
RO	country	**x**	**x**	**x**	---	---	---	---	1980-s
	county	---	---	---	---	---	---	---	
SE	Country	**x**	**x**	**x**	---	---	---	---	1996-2000
	County	---	---	---	---	---	---	---	
	Specific regions	**x**	**x**	**x**	---	---	---	---	
FI	Country	**x**	**x**	**x**	---	---	---	---	1986-1994
	County	---	---	---	---	---	---	---	
	Specific region	**x**	**x**	**x**	---	---	---	---	
CZ	Country	**x**	**x**	**x**	---	---	---	---	2000
	Region	**x**	**x**	**x**	---	---	---	---	
SK	Country	**x**	**x**	**x**	---	---	---	---	unkn.
	Region	---	---	---	---	---	---	---	
PO	Country	**x**	**x**	**x**	---	---	---	---	1993
	Voivodship	---	---	---	---	---	---	---	
	Regional Forest Directorate	---	---	---	---	---	---	---	
EE	Country	**x**	**x**	**x**	---	---	---	---	1999-2001
	County	---	---	---	---	---	---	---	
LV	Country	**x**	**x**	**x**	---	---	---	---	2000
	District	---	---	---	---	---	---	---	
LT	Country	**x**	**x**	**x**	---	---	---	---	2000
	County	---	---	---	---	---	---	---	
BL	Country	**x**	**x**	**x**	---	---	---	---	2001
	Oblast	**x**	**x**	**x**	---	---	---	---	
UA	Country	---	---	---	---	---	---	---	---
	Oblast	---	---	---	---	---	---	---	

x – available (or can be derived);
N – not available (can not be derived).

3.3.3. National information sources

If the data cannot be found in any of international databases, it may be available at the national level. Most of forestry related data (also in international forestry databases) stem from national inventories in each particular country. Thus, it might be possible to request the data at national institutions responsible for forest inventories and/or saving forest resource data. Forest inventory systems differ between countries in terms of applied methods, recorded attributes and definitions. There are two main types of forest inventories. One type is the national (or statistical) forest inventory (NFI) which is based on collecting data from a network of sample plots covering the whole country. The other most common type is stand-wise inventories when all forest stands are investigated but subjective estimation methods are used. Stand-wise inventories typically serve as a basis for forest management plans. Data from all stand-wise inventories are typically assembled in a country-wide database maintained by a state authority. The latter is sometimes referred to as the permanent inventory and the annual statistics as a summary forest management plan. Generally, national forest inventories provide a much larger range of records and give higher accuracy. The accuracy can be significantly influenced by the size of the area of reference which is an important aspect, since the subject of this study is the data on the sub-country level. The data of stand-wise inventory can be seemingly precise but usually is proved to be inaccurate when compared to the results of statistical inventories.

Bulgaria

The management of the state forest fund and control over all forests independent of the type of ownership is ensured by the National Forest Agency. Thus, the National Forest Agency possesses data on all forests in the country. A combined type of forest inventory is applied where mature forest is inventoried stand-wise, while the rest using sample plots (Metadata on Forest Inventories). There is no information available about any statistical publications or yearbooks concerning forestry. Some figures are available on the webpage of the National Forest Agency (www.nug.bg), but the records are in Bulgarian. A request concerning the availability of selected attributes was sent to the National Forest Agency and it was established that all required data can be provided. The eventual application of fees for such service is not stipulated in internal regulations, thus cannot be specified apriori (Vasilev N., 2007-28-08).

Romania

Romania is a special case in terms of forest related information. In Romania, stand-wise inventory is applied only in forest stands which are subject to felling within the next 10 years. For the rest of the forests, the growing stock is estimated only according to growth and yield models, while the data of the last inventory originates from the mid-eighties. Forest management plans are produced by the Forest Management Institute ICAS, while the National Forest Administration ROMSILVA only has data about state owned forests. The Institute for Statistics collects data on cuttings in all forests in the country and publishes a statistical yearbook on agriculture

and silviculture. The most recent available version is from 2004 and its results are shown in Table 8.

Table 8: Assessment of data availability in published sources in Romania

Unit of territorial division	Growing stock			Cuttings				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	---	---	---	**x**	**x**	---	**x**	Agriculture and Silviculture 2004
County	---	---	---	**x**	**x**	---	---	

X – available;
--- – not available;

Another way to access the information is through the online database of the Romanian Institute for Statistics (http://www.insse.ro). The attributes available in the database are almost the same as in the Statistical yearbook, with the difference that the online data is more recent and data on removals by county can be retrieved. To get access to the online database, registration is required. Access to certain tables is subject to a minor fee charge.
A request about selected data records was sent to the Forest Management Institute ICAS, National Forest Administration ROMSILVA and Romanian Institute for Statistics. As result of the request the following was established.

- It was confirmed that there was virtually no reliable data on growing stock in Romania (Marin, G., 2007-06-09) nor for the state owned forests which are under administration of ROMSILVA (Seceleanu, I., 2007-05-09)
- Data on executed cuttings could be provided by the Institute for Statistics (Goreac, I., 2007-08-09) The Institute for Statistics used a statistical survey among stakeholders having forestry activities to collect their information.

Estonia

Since 1995, the Centre of Forest Protection and Silviculture publishes an annual Forest Yearbook. The main chapters of the yearbook are downloadable on the Centre of Forest Protection and Silviculture's website. The results of the examination of the yearbook are shown in Table 9.

Table 9: Assessment of data availability in published sources in Estonia

Unit of territorial division	Growing stock			Cuttings				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	**x**	**x**	**x**	**x**	---	**x**	---	Yearbook Forest 2006
County (maakond)	**x**	---	---[1]	**x**	---	**x**	---	

X – available;
--- – not available;
[1] - analogous attribute of area available

The yearbook contained data on forest area by species and age classes but did not contain analogous records of growing stock. A request about selected data records was sent to the NFI division of the Centre of Forest Protection and Silviculture. It was established that the Centre of Forest Protection and Silviculture could provide all the needed data for free. However, a significant statistical error in the case of calculating attributes by species and county can be expected because of the lesser area in accordingly lesser number of sample plots. (Adermann V., 2007-15-08)

Latvia

In Latvia, the countrywide forest resource database is based on data from stand-wise inventories. Legislation requires an inventory to be made in each forest estate at least once every ten years. The inventories data is actualized according to the annual reports of performed management activities and growth models. A pilot National Forest Inventory (NFI) was launched a few years ago and the first round of NFI is still being carried out.
The Ministry of Agriculture annually publishes a brochure titled “Forest Sector in Latvia”, while the State Forest Service compiles annual Forest Statistics which are available on CD. The published sources were examined, subject to the availability of selected data records. The results of the assessment are shown in Table 10.

Table 10: Assessment of data availability in published sources in Latvia

Unit of territorial division	Growing stock			Cuttings				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	---	**x**	---	---	---	---	---	Forest Sector in Latvia 2006
District (Rajons)	---	---	---	---	---	---	---	
Entire country	**x**	**x**	**x**	**x**	**x**	**x**	---	CD "Forest Statistics 2006"
District (Rajons)	**x**	**x**	**x**	**x**	**x**	**x**	---	

X – available;
--- – not available;

The brochure, "Forest sector in Latvia 2006", did not contain any of the checked records at the sub-country level. The compilation of Forest Statistics by the State Forest Service comprised all selected records except removals by assortment. There is no reliable information on the exact distribution of round wood by assortments. The drawback of the Forest Statistics is that it is not available via the internet and is distributed only on CD.

Lithuania

In Lithuania, both stand-wise and National forest inventories are conducted. The first NFI was started in the late 1990's. The implementation of the NFI and the maintenance of the forest cadastre are ensured by the State Forest Survey Service. The State Forest Survey Service publishes the Lithuanian Statistical Yearbook of Forestry annually. Most records are shown by forest ownership type and forest category. With regard to territorial reference units, most attributes are presented by the State Forest Enterprise with only a few by thecounty. The assessment results of the yearbook are shown in Table 11.

Table 11: Assessment of data availability in published sources in Lithuania

Unit of territorial division	Growing stock			Cutting				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	**x**	**x**	**x**	**x**	---[1]	---[1]	---	Statistical yearbook of forestry 2006
County	**x**	**x**	---	---	---	---	---	

X – available;
--- – not available;
[1] - analogous attribute of area available

A request about selected data records was sent to the Lithuanian State Forest Survey Service and the following was established (Kuliešis A., Personal communication).

- State Forest Survey Service calculates most of the derived attributes per State Forest Enterprise (42) but not by county.
- The Service being a state budgetary institution is not delegated to produce special statistics by external order

Finland

The first NFI in Finland was carried out in the 1920's (NFI1 1921-1924). It was among the first inventories in the world based on statistical sampling. Since then NFIs have been conducted regularly in 5 to 10 year cycles. The latest forest statistics are based on the 10th NFI whose field measurements were started in the summer of 2004 (http://www.metla.fi/ohjelma/vmi/info-en.htm). The institution responsible for carrying out the NFI and embedding the Forest Information system in Finland is the Forest Research Institute, METLA. METLA publishes an annual Statistical Yearbook of Forestry in the Finnish language with an English abstract and figures doubled in English. The yearbook is available on METLA's website. Examination results of the yearbook are shown in Table 12.

Table 12: Assessment of data availability in published sources in Finland

Unit of territorial division	Growing stock			Cuttings				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	**x**	**x**	---[1]	**x**	**x**	---[1]	**x**	Statistical Yearbook of Forestry 2006
Forestry Centre	**x**	**x**	---	**x**	**x**	---[1]	**x**	
Province (län)	---	---	---	---	---	---	---	

X – available;
--- – not available;
[1] - analogous attribute of area available.

The Statistical Yearbook of Forestry did not present any records by province but only by Regional Forestry Centres or for the entire country. There are 13 Regional Forestry Centres under the supervision of the Ministry of Agriculture and Forestry. Their task is to promote forestry and enforce the forest legislation locally. A request about the selected data records was sent to METLA's forest statistics division and the following was established (Mustonen, M., 2007-24-08)

- A province is not the standard level for calculating forest statistics in METLA, which requires additional calculations. The charge for the work and the data was approximately 1300 SEK

Sweden

The National forest inventories in Sweden have been undertaken since 1923. The inventories (the Swedish NFI) have been carried out by the Department of Forest Resource Management and Geomatics, Swedish University of Agricultural Sciences(SLU) in Umeå (http://www-nfi.slu.se).
The information is disseminated by SLU and by the Swedish Forest Agency (former National Board of Forestry). The Swedish Forest Agency publishes the Swedish Yearbook of Forestry in English and Swedish based on the NFI data received from SLU on an annual basis. SLU publishes its own compilation of inventory data called Skogsdata, which is aimed towards the research staff. The Statistical Yearbook and some additional data are accessible on the Swedish Forest Agency's website. The examination of the publications is shown in Table 13.

Table 13: Assessment of data availability in published sources in Sweden

Unit of territorial division	Growing stock			Cutting				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	**X**	**X**	---[1]	**X**	**X**	---[1]	**X**	Swedish Statistical Yearbook of Forestry 2007
County (län)	**X**	**X**	---	**X**	---	---[1]	---	

X – available;
--- – not available;
[1] - analogous attribute of area available.

The proportion of final cuttings and thinning was characterized by area and given only for the entire country. A request about selected data records was sent to the SLU NFI division and the following was established (Nilsson, P.,):

- Growing stock by species and age classes can be retrieved in the interactive Riksskogstaxeringens database (available only in Swedish language) on www-taxwebb.slu.se/;
- The requested records on fellings can be provided as a five year average, but only for the regional levels i.e. Northern Norrland, Southern Norrland, Svealand, Götaland. This would require additional calculations which would amount to approximately 1000 SEK;
- The data on removals by assortment cannot be provided.
- In principle, NFI cannot provide reliable data for smaller territories because of increasing statistical errors.

Czech Republic

In Czech Republic forest inventories are carried out and forest management plans are prepared by Forest Management Institute UHUL. The first National Forest inventory in Czech Republic was carried out during the years 2001 – 2004. Before that the national forest information system was based on compilation of valid forest management plans with data from stand-wise inventories. The Forest Management Institute runs the Information and Data Centre (IDC) for the forest and game management sector in Czech Republic among other tasks of which is ensuring the accessibility of data for the forest sector administration and interested public. The Ministry of Agriculture publishes an annual report on the state of forests and forestry (available in English). A brochure on the results of the first National Forest inventory is also available. The results of the assessment of the published sources are shown in Table 14.

Table 14: Assessment of data availability in published sources in Czech Republic

Unit of territorial division	Growing stock			Cuttings				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	**x**	---	---	**x**	**x** [1]	---	**x**	Information on Czech Forestry 2006
Region (kraj)	---	---	---	---	---	---	---	
Entire country	**x**	**x** [1]	---	---	---	---	---	Results of NFI 2001 - 2004
Region (kraj)	**x**	**x** [1]	---	---	---	---	---	

X – available;
--- – not available;
[1] - data presented by coniferous/ broadleaves

A request about selected data records was sent to the Forest Management Institute UHUL and the following was established (Fryml, J., 2007-05-09):

- The Forest Management Institute has all the listed figures, with the exception of final felling/ thinning volumes, which is represented in terms of area, and removals by assortment by region;
- The data can be provided with no fee applied.

Slovakia

Institute for Forest Resources and Information Zvolen is responsible for the forest information system in Slovakia. The institute is a part of the larger National Forest Centre of the Slovak Republic (former Forest Management Institute Lesoprojekt Zvolen). The Institute prepares forest management plans for most of the forests in Slovakia. The forest information system is currently based on the Summary forest management plan and on the stand-wise forest inventories data. In 2005 the first National Forest Inventory was published (Report on Forestry in the Slovak Republic, 2006). The Ministry of Agriculture publishes an annual report, known as the Green Report, on forestry in the Slovak Republic (available in English). The results of the assessment of the Green Report 2006 are shown in Table 15.

Table 15: Assessment of data availability in published sources in Slovakia

Unit of territorial division	Growing stock			Cuttings				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	**x**	**x** [1]	---	**x**	**x** [1]	**x**	**x**	Green Report 2006
Region (kraj)	---	---	---	---	---	---	---	

X – available;
--- – not available;
[1] - data presented by coniferous/ broadleaves

A request about selected data records was sent to the Forest Management Institute Lesoprojekt Zvolen and the following was established (Kmetova, Z., 2007-26-09)

- Data on cuttings are available only by groups of species (coniferous/ broadleaved) instead of individual species;
- Data on the removals by assortment presently are available only by other territorial units (West, Central, East) instead of the standard region *(kraj)*;
- The rest of the requested data was available free of charge;

Poland

The type of the forest inventory in Poland is combined since part of the data originates from stand-wise inventories and part from the system of sample plots (Metadata on Forest Inventories, Joint research Centre of the European Commission, available at http://afoludata.jrc.it/carboinvent/cimd_eufoin_data).
The forest information system in Poland is shaped by the forest ownership structure. The dominant provider of forest inventories is the Office of Forest Management Planning and Forest Geodesy. According to the Forest Act of 1997, a national inventory of all the forest properties and establishments of the national forest data bank is required. Currently, updated forest district inventory data is the main source for the national system, which is supplemented by information from Forest Health Monitoring carried out by the Forest Research Institute. The forest information system is administrated by State Forest Holding (Michalak R.). The State Forest Holding publishes yearbooks titled “Forests in Poland” and “The State Forests in Figures” (both available in English). The yearbook Forests in Poland is based on the annual report on the state of the forests. The yearbook is prepared by the Forest Research Institute in Warsaw by the order of the State Forest Holding which is consulted at different authority levels and finally accepted by the Parliament. The assessment results of the yearbook are shown in Table 16.

Table 16: Assessment of data availability in published sources in Poland

Unit of territorial division	Growing stock			Cuttings				Source
	Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment	
Entire country	**X**	---	---	**X**	---	---	---	Forests in Poland 2006
Reg. Forest Directorate	---	---	---	---	---	---	---	

X – available;
--- – not available;

The forest yearbook in Poland 2006 included a few of the attributes selected for this study but none at the level of the Regional Forest Directorate. A request about the selected data records was sent to the General Directorate of State Forests National Forest Holding and the following was established (Wojcik, T., 2007-21-08):

- State Forests National Forest Holding can provide all indicated data;
- A special request form is required to obtain unpublished data (the form is available on the webpage of State Forests National Forest Holding, www.lp.gov.pl);
- Some attributes are presented by the group of tree species and not by the individual tree species;
- Fees are limited to the reimbursement of eventual preparation and dispatching costs.

Ukraine

A major portion of the Ukrainian forests are under the administration of the Ukrainian State Committee of Forestry (USCF) which is under the authority of the Ministry of Ecology and Natural Resources. Forest inventories are carried out and forest management plans are produced by the state enterprise, UKRGOSLESPROJEKT. Forests are inventoried using the stand-wise forest inventory method. UKRGOSLESPROJEKT has the inventory data on all the forest resources. The State Committee of Forestry has the information on the actual management activities such as executed cuttings. There is no statistical publication on forests such as a forestry yearbook published in the internet. Several attempts to establish a contact with UKRGOSLESPROJEKT undertaken by the author failed.

Belarus

In Belarus all forests are state owned. The management of more than 86% of the forests is ensured by the Ministry of Forestry of the Republic of Belarus. Forest

inventories and forest management plans for regional state forest enterprises are executed by the state owned forest management planning enterprise, “BELGOSLES,” by the order of the Ministry of Forestry. The BELGOSLES has the inventory data on forests and figures with regard to planned management activities. The Ministry of Forestry has the data on actual executed cuttings. Certain figures, such as growing stock and actual cuttings, are available on the website of the Ministry of Forestry. No other statistical publication on Belarusian forests, such as a forestry yearbook, was found. A phone communication with an employee at the BELGOSLES established the following:

- A formal request has to be sent to the Director General or Chief Engineer of the enterprise in order to apply for any type of information.
- Depending on the decision of the request, it could be relegated to an inferior unit for further processing or denied.
- Basic information on forest resources is not considered confidential; however, it is intended for internal use at the Ministry.
- There is an annual report which is produced for internal use and is not disseminated publicly (Parshin S.).

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3.3.4. Summary of data availability assessment

The summary of the availability assessment of the selected forest related data on the relevant territorial unit levels is shown in Table 17. The choice of the territorial units was based on the results of the first part of this study. The assessment included online databases, statistical publications such as forestry yearbooks and data accessibility on request at the relevant authority.

Table 17: Availability assessment of selected forest resource data in selected countries at a selected territorial unit level.

Country	Unit of territorial division	Growing stock			Cuttings			
		Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment
BG	R. Dep. of For.	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**
RO	County	---	---	---	**x**	**x**	**---**	**x/-**
SE	County	**x**	**x**	**x/-**	**x**	---[1]	---[1, 2]	---
FI	Province	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**
CZ	Region (*kraj*)	**x**	**x**	**x/-**	**x/-**	**x/-**	---[2]	---
SK	Region (*kraj*)	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**[3]	**x/-**	---[1]
PO	Reg. For. Dir.	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**	**x/-**
EE	County	**x**	**x**	**x/-**	**x**	**x/-**[4]	**x**	**x/-**
LV	District	**x**	**x**	**x**	**x**	**x**	**x**	---
LT	County	**x**	**x**	---	---	---	---	---

Continuation of Table 17

Country	Unit of territorial division	Growing stock			Cuttings			
		Growing stock	Growing stock by species	Growing stock by species by age classes	Actual cutting	Actual cutting by species	Final felling/ thinning volumes	Removals by assortment
BL[5]	Region *(oblast)*	**x**[6]	**x**[6]	**x**[6]	**x/-**	**x/-**	**x/-**	**x/-**
UA	Region *(oblast)*	not assessed						

x – available in published sources;
x/- - available on request;
--- - not available/existing;
[1] data available only for larger territorial units;
[2] corresponding feature in terms of area;
[3] data presented by coniferous/ broadleaves;
[4] large statistical error is likely;
[5] depending on the decision of the authority;
[6] data older than 5 years.

Data on growing stock and growing stock by species at the selected territorial unit level is missing for Romania due to growing stock not having been inventoried in the country for more than two decades. Statistics on growing stock by species and age classes at the selected territorial unit level are not available for Lithuania and Romania. Data on actual cuttings and cuttings by species for the chosen territorial unit is also not available for counties in Lithuania. In Lithuania these statistics are available for the State forest enterprises but not for counties. Data on actual cutting by species for the selected territorial unit is not available for Sweden because the NFI cannot calculate reliable data for small territories. Cutting volumes by cutting method (final felling/thinning) at the selected territorial unit level are not available for Romania, Sweden, Czech Republic and Lithuania. In some cases the shares of the different cutting methods are characterized by area instead of harvested volumes while in other cases this attribute cannot be applied due to different silvicultural methods used in a given country (e.g. Romania). Volumes of removals by assortment are not available for Sweden, Czech Republic, Slovak Republic, Latvia and Lithuania. In some cases this kind of information is not available because of the chosen territorial unit, while in other cases there are no records of such data, in general. In a number of cases the data is available but only by groups of tree species (coniferous/ broadleaves or sometimes coniferous/ soft broadleaved/ hard broadleaved) instead of individual tree species.

3.4. System functionality

While the first two sections of this study focused on issues related to the first basic component of GIS according to Päivinnen and Köhl (2005), the third section of this study will address the questions related to the second and the third components of GIS: (ii) data storage and management, and (iii) information retrieval.

3.4.1. Required basic system functionality

Different user groups of GIS should be able to carry out certain operations according to their access level. Below are a few basic tasks specified for each of the potential user groups:

- IKEA forestry staff:
  - enter, visualize and edit forest tracing system data and wood procurement planning data;
  - perform risk assessment at the defined regional level for audit planning purposes;
  - obtain wood volume summaries (in maps and tables) from forest tracing data and wood procurement planning data;
  - export and save maps, tables, forest tracing and wood procurement planning data.
- Suppliers:
  - enter, edit and visualize forest tracing data and wood procurement planning data of their own;
  - obtain their own wood volume summaries by defined regions or territorial units.
- Buyers:
  - visualize wood origin regions for a certain product or for a certain supplier enterprise.

In order to enable users to perform the described operations, the system must embody corresponding functionality. A few functions that are essential for the system are described as the following:

- Data visualization: the user can see boundaries of the wood origin regions as used in the IKEA forest tracing system. Obtained maps can be converted to other formats for using outside the system.
- Information retrieval and visualization: the user should be able to make the following type of queries: select the regions where…
  - a single supplier A
  - or several selected suppliers
  - or all suppliers

  obtain in the specified period f(x) or f(x+1)
  - wood of a tree species B
  - or wood of several selected tree species
  - or wood of all listed tree species
- Data analysis and summary function: the user should be able to make the following type of analysis: according to the supplied wood volume (total and certified) rank the regions (or/and countries) where…
  - a selected supplier A
  - or several selected suppliers

- or all suppliers

obtain in the specified period f(x) or f(x+1)

- wood of a tree species B
- or wood of several selected tree species
- or wood of all listed tree species.

3.4.2. Sample database

In order to realize the capabilities of the software, the input data needs to be organized on the basis of the spatial and attribute data described in the Materials and Methods section. A sample database was created in order to explore and define structure and relationships needed to enable the described functionality. The structure of the created sample database is shown in Figure 3.

In order to connect spatial data feature classes to other feature classes and attribute data tables, relationship classes were created. Relationship classes connect different database components based on identical data fields. Relationships between database components can be simple or complex implying automatic updating of related data fields and other functions. Relationship classes allow users to navigate between connected database elements. The sample database created for this study was developed according to the functionality of the GIS software, ArcView 9.2. The sample database was structured in the following way:

- The Districts feature class was related to the Countries feature class by a relationship class based on the attribute field, Countries ID.
- The Regions feature class was related to the Wood supply data table by a relationship class based on the attribute field containing Region ID.
- The Countries feature class was related to the Wood supply table by a relationship class based on the attribute fields Countries ID and WoodCountry.
- The Regions feature class was related to the forest resource data table by a relationship class based on the attribute field, Regions ID.

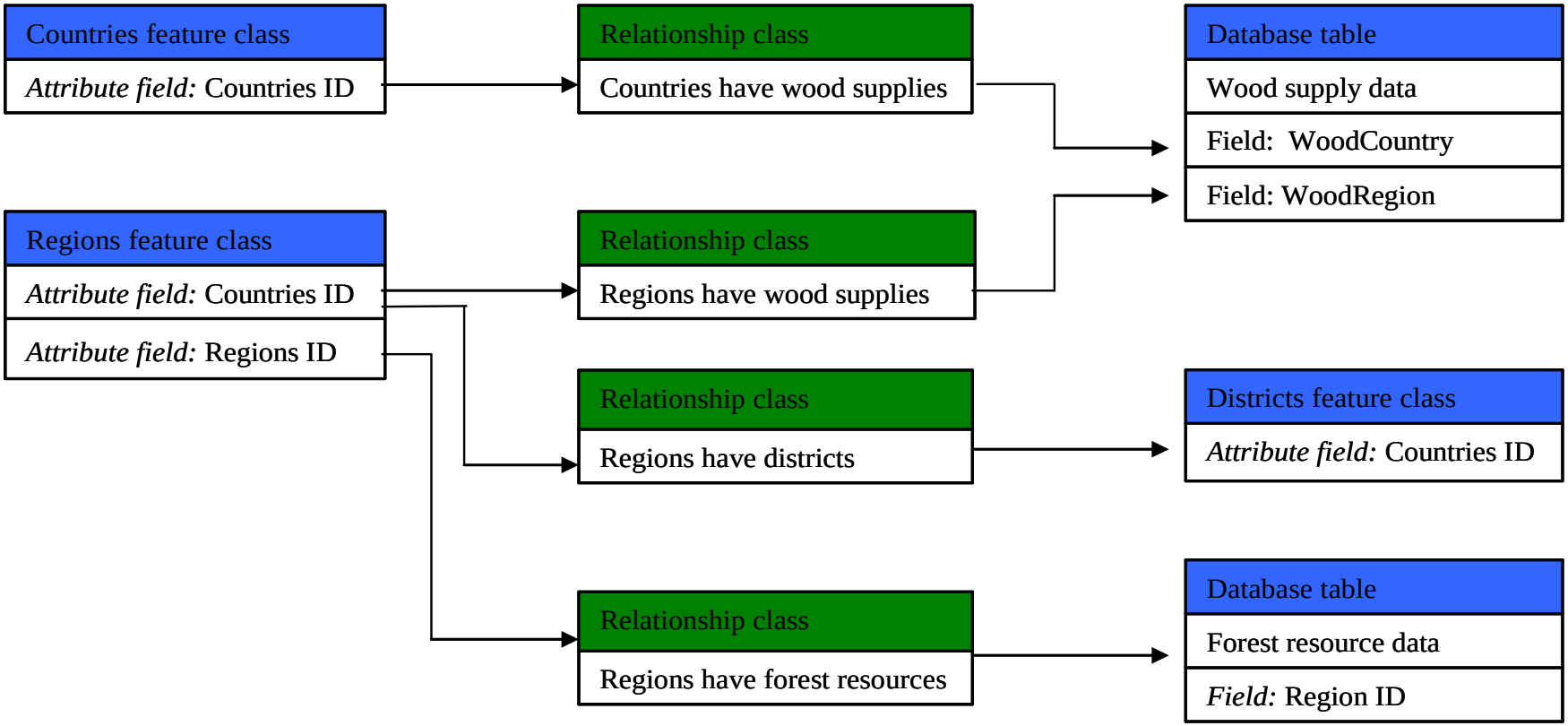

Figure 3. Structure of the sample database: the boxes with the blue headings represent feature classes and database tables, while the boxes with the green headings represent relationship classes.

3.4.3. Examples of basic functions

Using the sample database and GIS software, several types of simple functions were simulated in order to provide examples of possible system use. The examples are illustrated with screenshots of the GIS software, ArcView 9.2, showing different steps in the execution of the tasks.

In Figure 4, the ArcView 9.2 window is shown with all feature classes with the wood supply data table.

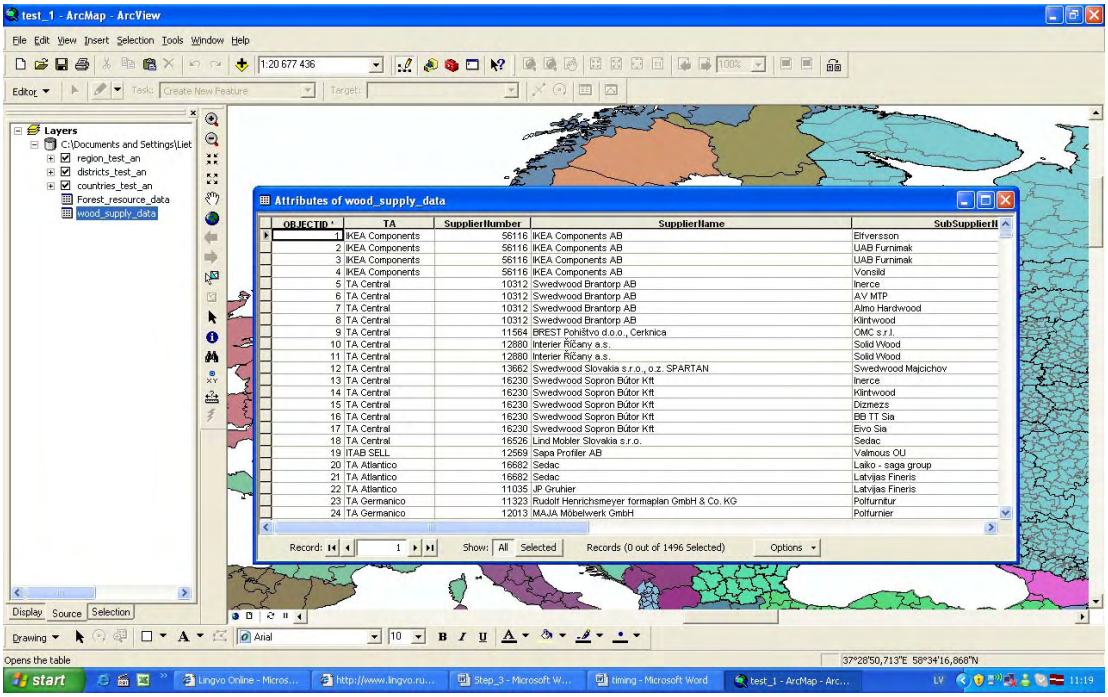

Figure 4. A screen capture of ArcView 9.2 with all feature classes and the wood supply data table of the sample database

Figure 5 presents a query entered in the ”select by attribute” box and the wood supply data table with the corresponding entry highlighted. The query expression can be formulated so as to select map features depending on the values of chosen data (or attribute) fields (e.g. supplier name, wood species etc.) or on the relationships between the fields.

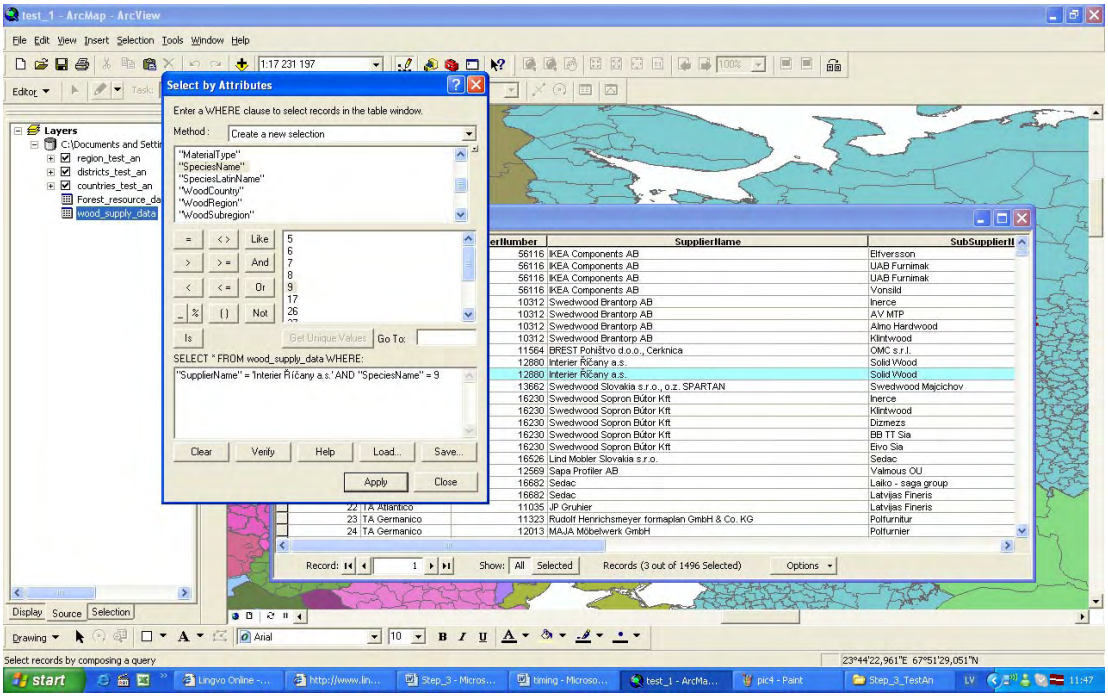

Figure 5. A screen capture of ArcView 9.2 with the "select by attribute" box and an entry in the wood supply data table highlighted

In Figure 6, the regions resulting from the selection query can be seen highlighted on the map.

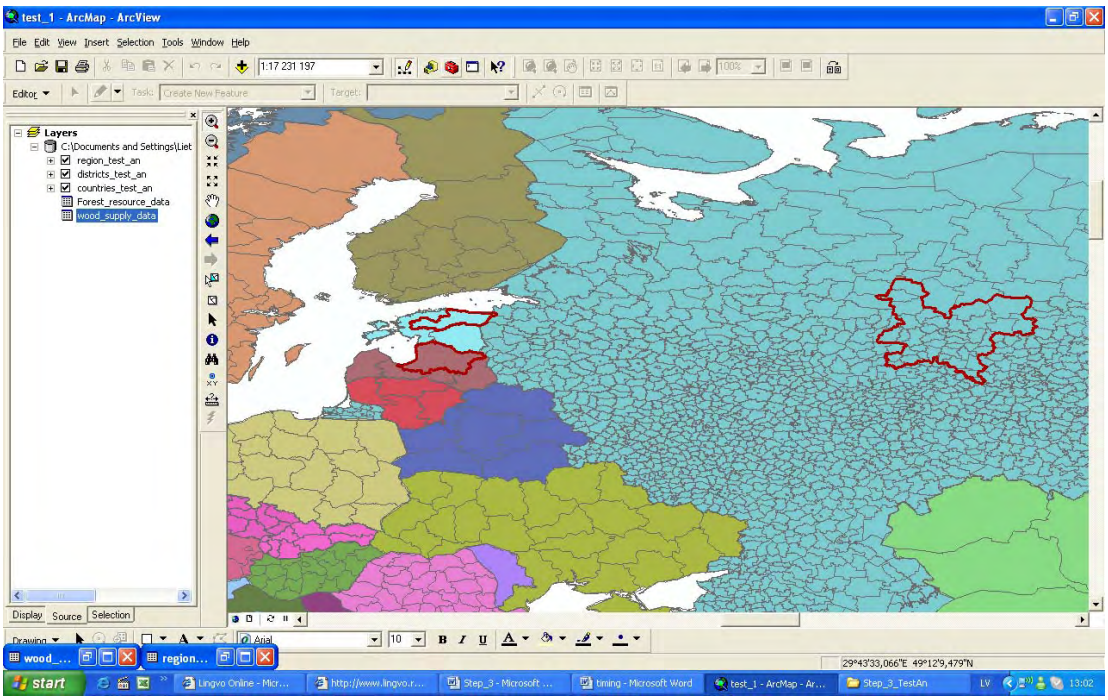

Figure 6. Regions selected according to the query seen in Figure 5

An inverse task can also be easily carried out. Having selected given features on the map, according entries in the wood supply data table are highlighted (Figure 7).

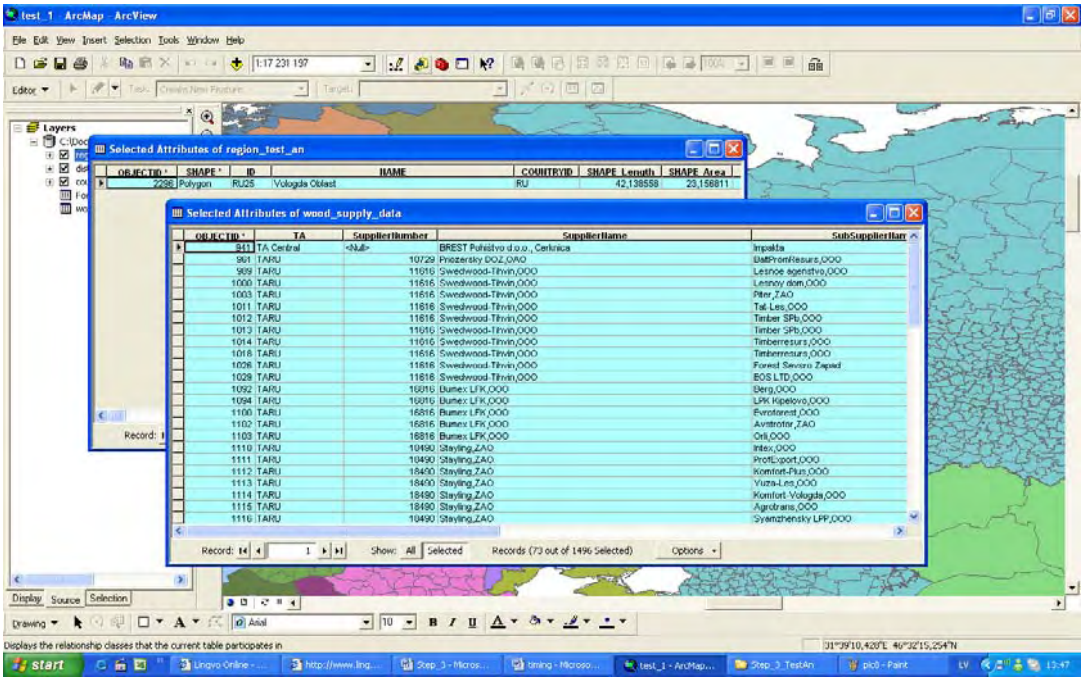

Figure 7. The wood supply data table with all entries related to selected map feature highlighted

The selected entries in the wood supply data table can be summarized or ranked by chosen data (attribute) fields (e.g. supplier, wood species, product type etc). For example, a list with different suppliers and their respective wood volumes for a given region is retrieved by summarizing wood volumes by suppliers (Figure 8).

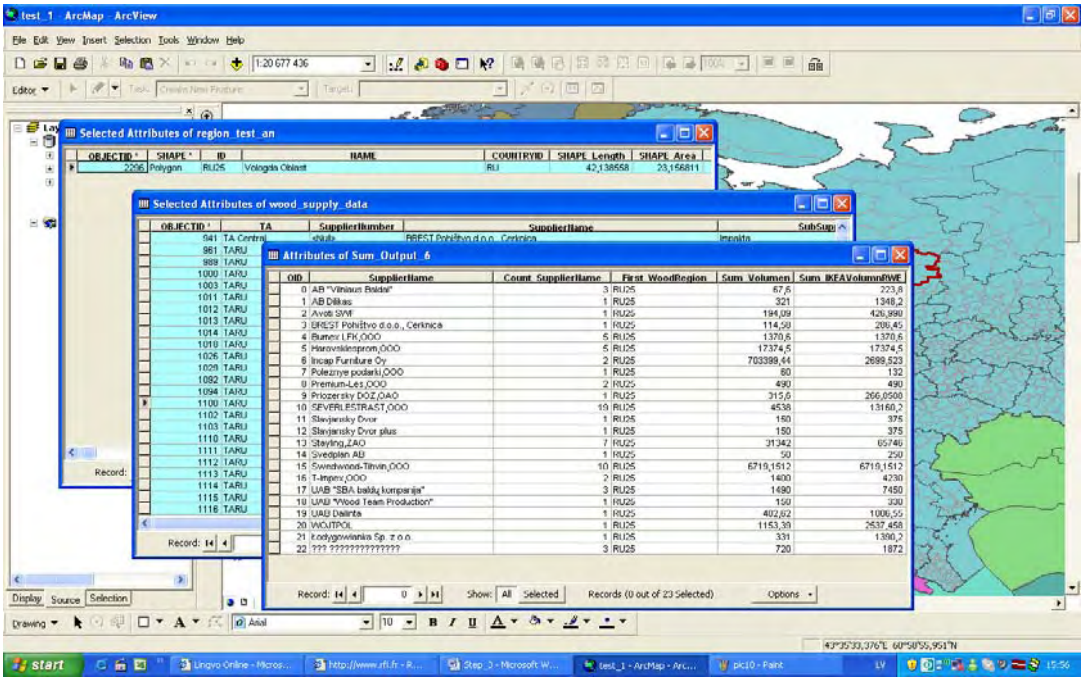

Figure 8. Wood volumes summarized by supplier for a chosen region (map feature).

The previous examples show that the structure of the sample database and the standard functionality of the software make it possible to carry out information retrieval, visualization and data analysis as described in the previous section.

Another visualization capability of GIS is constructing graphs. Graphs are highly useful in preparation of different presentations and reports. ArcView 9.2 saves graph settings so that they apply to every selected map feature. The more attributes related to the map, the greater the possibility to present various types of rankings and comparisons. For example, Figure 9 shows how a graph can be used for presenting purchased wood volumes of tree species as compared to the total cuttings for two selected regions.

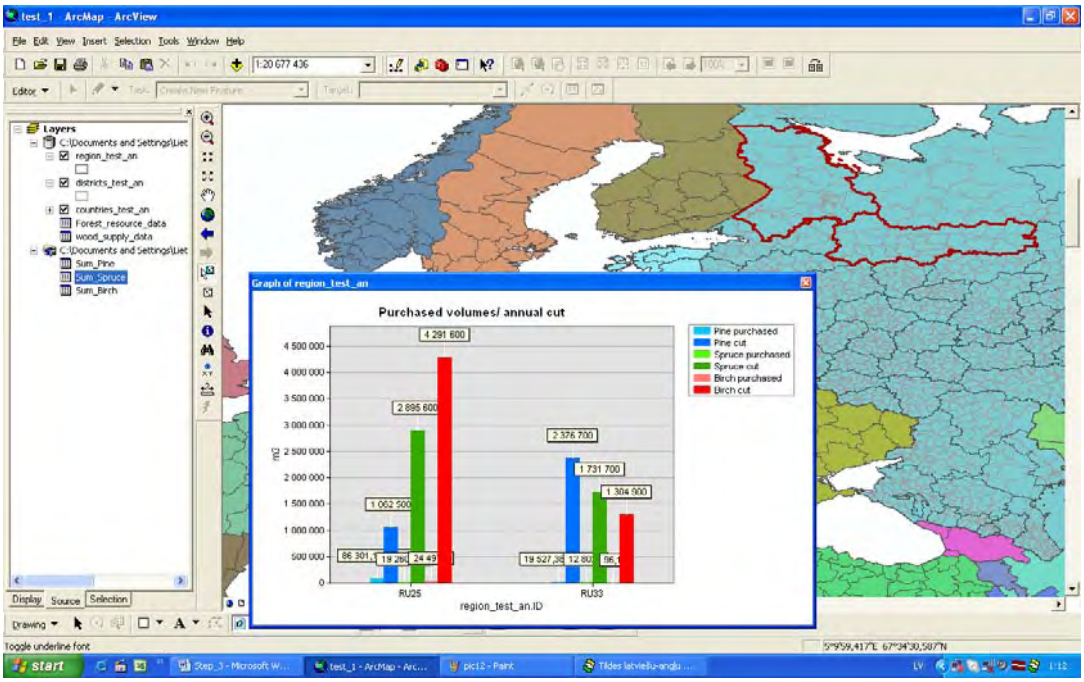

Figure 9. Graphs presenting purchased wood volumes and total cuttings in selected regions (map features)

4. DISCUSSION

Reviewing the results of the literature about comparable GIS in other forest sector companies, it can be concluded that similar concepts are used in other companies purchasing large quantities of wood. However, IKEA is not involved in forest operations directly, therefore, the GIS is not intended to be a logistics tool at forest operations levels. In case of IKEA, the communication and data analysis facets of GIS are going to play a more important role.

The results pertaining to the wood origin region show that the spread in the size of the same-level territorial units can be very large both within one country and between different countries. It can be concluded that, in some cases, the average area is not suitable as a criterion in the discussion about the choice of territorial units for reporting wood origin.
In Poland and Bulgaria, where the forest administration (or management) territorial units do not match the boundaries of the countries' administrative units, the former should be chosen for the forest tracing system due to the results regarding the forest resource data availability. In Lithuania, the number of state forest enterprises is so high (42) that an aggregated solution needs to be considered.
The option of defining groups of existing territorial units as larger units for wood origin reporting purposes is possible. The aspect of choice between larger and smaller territories for wood origin reporting was discussed in detail in Chapter 3.2.
However, looking at the country-specific characteristics it is reasonable to recommend defining larger regions based on the groups of existing territorial units in some of the selected countries. Taking into account the aspects of the number of regions, role of the forest administration and forest resource data availability, the following region definitions are recommended: Estonia – counties grouped in 3 wood origin regions, Latvia – districts grouped in 4 wood origin regions, Lithuania – counties grouped in 3 wood origin regions, Bulgaria – Regional forest directorate, Romania – Regional forest directorate/ county, Sweden – county *(län)*, Finland – province *(län)*, Poland – Regional forest directorate, Czech Republic – region *(kraj)*, Slovakia – region *(kraj)*, Belarus – province *(oblast)*, and Ukraine – province *(oblast).*

The results of the forest resource data availability assessment showed that data availability at the chosen territorial unit level differ among the countries. In approximately half of the cases when certain data was not available at the chosen territorial unit level it was not because of the choice of the territorial unit (region) but rather due to the data being available only at the country level or not at all (e.g. Romania). However, in Lithuania, most of the records not available at the county level that the assessment was focused on were available for State forest enterprises.
For this study, it was impossible to obtain data at the chosen territorial unit level for all the selected countries. Therefore, it can be asked whether then the data base should be limited to the entries universally available or no value entries should be allowed. As for the first option, it has to be pointed out that even with the small number of countries included in the study at least one data entry was missing for each country. In the second case, a wider range of data would be available for some countries but not for all the countries, which made the possibilities for comparisons and rankings by chosen attributes to be limited. It is important to make distinguishable "no value" entries from "0" values in order to avoid incorrect

interpretations. From a technical point of view, the compilation of the forest resource data into the database tables requires a considerable amount of time. The typical form that data can be obtained is in Excel worksheets. The fact that the terms in many cases are given only in national languages without English translation also requires additional time. Further, updating periods should be defined for the data.

In regards to the system functionality, the creation of the sample database is the main result. Descriptions of the essential tasks envisaged for the system are based on the discussions with IKEA staff involved in the project (Alexey Naumow, Kjell-Owe Ahlskog). The practical examples of carrying out some of the tasks indicate that the structure integrated in the sample database is principally correct.

The execution of the examples as presented in this study is based on the elementary functionality of the GIS. By the means of custom-programming, such tasks can be solved in more efficient ways and more sophisticated functions can be added.
Saved graph settings are a useful tool for producing reports and presentations. The visualization capabilities of the system can constitute a powerful communication and support tool for analysts. For example, the possibility of highlighting on the map the regions where certain suppliers obtain their wood resources can provide a perfect view of the geographic extent of supplier's operations and can allow for a more efficient identification of possible overlaps with other suppliers.

There are many technical aspects that were not touched upon in this part of the study. However, it gives valuable insight into the possibilities of the system.

5. CONCLUSIONS

1. Administrative units in some countries significantly vary in size, thus, the choice of region definitions for IKEA's forest tracing system cannot be primarily based on the average area of regions.

2. Forest resource data on the regional level is partly available in the countries selected for this study.

3. The provision of the forest resource data is not commercialized for any of the countries involved in this study. Minor fees may be necessary to cover the costs when additional calculations are needed.

4. Some of the forest resource data at the chosen regional level can be retrieved from published sources.

5. The input data such as the forest resource data and the company's forest tracing data need to be specifically structured in order to enable GIS to execute relevant information retrieval and analysis tasks. The sample database, allowed for numerous tasks to be executed in the GIS software, ArcView 9.2. The functionality of ArcView 9.2 meets the requirements for the structure of the sample database and, therefore, can be used as an integrated application tool for IKEA's wood sourcing system.

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