International perceptions of university forestry education – an analysis of student motivation, competencies, and curricula

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Academic dissertation

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ABSTRACT

The field of forestry is currently facing numerous challenges. These include new demands from people and organisations with regard to governance and services from forests, ecological and environmental functions, and the global competition and market pressure over forests and its products. In order to provide students with the knowledge, abilities and attitudes required in the profession, universities around the world need to consider the challenges faced by the sector as well as the latest technological and pedagogical innovations. Consequently, a great number of higher forestry education institutions have reformed their programmes or at least initiated their reform processes especially within the last decade. In this context, this thesis investigated the perceptions of students, universities and employers on various aspects of national forestry education and the forestry profession from an international perspective. Particularly, the issues of student motivation, subject-specific and generic competencies, curricula, and employment prospects were examined. A mixed methods strategy was used, combining quantitative and qualitative approaches. The case studies of three Bachelor's degree programmes in China, Brazil and Finland, and one international Master's programme, were selected, examining the perceptions of altogether 604 students. This was coupled with a pan-European survey of forestry universities and employers and an extensive literature survey.

The study provides numerous findings with regard to the similarities and differences in perceptions that universities, employers and students – across study years and countries – have on forestry education. Among the cross-national similarities, forestry students were highly interested in field studies and the areas of environmental protection and climate change, with a general preference for working after graduation in the area of management of public forests. Across study years, students from later study years gave a higher importance to communication skills in relation to students from earlier years; conversely, the importance given to achieving their best decreased along the years of the degree, signalling certain demotivation. Differences across countries were also found, such as the higher value given by Chinese respondents to autonomy skills, as compared with Finnish students who emphasised communicative skills, and to Brazilians who highlighted instrumental skills. In Europe, both universities and employers saw important gaps between the needs of the job market and the education provided at the universities, especially with regard to environmental services, carbon sequestration, and the ability to communicate. Employers saw a greater gap in relation to universities in areas such as bioenergy, forest products trade and marketing, economics and governance. Based on these and other findings, a clear need for improving current university forestry education is seen. A set of concrete recommendations for the reflection of those involved in the development of forestry education is presented.

Keywords: forestry education, curriculum development, competencies, job market

ACKNOWLEDGMENTS

LIST OF ORIGINAL ARTICLES

The thesis is based on the following articles, which are listed below, and referred to by Roman numerals.

Articles I – III are reproduced with the kind permission from the publishers. Article IV is the author version of the manuscript.

I Arevalo, J., Tahvanainen, L., Pitkänen, S. and Enkenberg, J. 2011. Motivation of Foreign Students Seeking a Multi-Institutional Forestry Master´s Degree in Europe. Journal of Forestry 109 (2): 69-73.

II Arevalo, J., Jarschel, B. Pitkänen, S., Tahvanainen, L. and Enkenberg, J. 2010. Differences in Forestry Students' Perceptions across Study Years in a Brazilian Undergraduate Program. Journal of Natural Resources and Life Sciences Education 39: 94-101.
doi:10.4195/jnrlse.2010.0003

III Arevalo, J., Pitkänen, S., Gritten, D. and Tahvanainen, L. 2010. Market-relevant competencies for professional foresters in European graduate education. International Forestry Review 12 (3): 200-208.
doi:10.1505/ifor.12.3.200

IV Arevalo, J., Mola-Yudego, B., Pelkonen, P. and Qu, M. 2011. Students' views on forestry education: a cross-national comparison across three universities in Brazil, China and Finland. Manuscript.

Javier Arevalo has the main responsibility for all the work done in Papers I-IV. Co-authors have participated in the work by commenting on the manuscripts.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

ANAFE	African Network for Agriculture, Agroforestry and Natural Resources Education
AUFSC	Association of University Forestry Schools of Canada
EFI	European Forest Institute
ENGO	Environmental Non-Governmental Organisation
FAO	Food and Agricultural Organization of the United Nations
FTP	Forest-Based Sector Technology Platform
GIS	Geographical Information Systems
ICRAF	International Centre for Research in Agroforestry (World Agroforestry Centre)
ICT	Information and Communication Technologies
IFSA	International Forestry Students' Association
IPFE	International Partnership for Forestry Education
IUFRO	International Union of Forest Research Organizations
MCPFE	Ministerial Conference on the Protection of Forests in Europe (Forest Europe)
MScEF	M.Sc. European Forestry programme
NWAFU	Northwest Agriculture and Forestry University, China
OECD	Organisation for Economic Co-operation and Development
PCA	Principal Component Analysis
PROFOR	Program on Forests
RELAFOR	Latin American Network on Forestry Education
SEANAFE	Southeast Asian Network for Agroforestry Education
SFA	State Forestry Administration of China
UEF	University of Eastern Finland
UFPR	Federal University of Paraná, Brazil
UNFF	United Nations Forum on Forests

Se vogliamo che tutto rimanga come è,

bisogna che tutto cambi.

– Giuseppe Tomasi di Lampedusa, "Il Gattopardo"

1. INTRODUCTION

In recent times, there has been intensifying discussions revolving around various aspects of forestry education. An example of this are the recent thematic sessions that were held at the most important international forestry meetings such as the World Forestry Congress in Buenos Aires (2009) and the IUFRO World Congress in Seoul (2010). In addition, a new International Symposium on Forestry Education has been created, with events organised in Beijing (2008) and Vancouver (2010), counting on the support of the International Partnership for Forestry Education (IPFE). IPFE, a relatively new organisation, acts as the network of the increasing number of national and regional forestry education networks, mainly the SILVA Network in Europe, ANAFE in Africa, SEANAFE in South East Asia, RELAFOR in Latin America, AUFSC in Canada, the Asia Pacific Forest Education Network, and the Chinese Education Association of Forestry. In addition to individual universities and national stakeholders, organisations such as FAO, IUFRO, UNFF, the Forest Technology Platform, IFSA, EFI, ICRAF and PROFOR are active parties in the debate.

There is a variety of issues facing forestry education today, which are of common concern and to some extent have been addressed in such discussions. These are:

1) the perception that current forestry education need to evolve with the changing societal demands with respects to forests (e.g. Bengston 1994, Nair 2004), including:

   a)   the demands for an emphasis on conservation, biodiversity, multifunctional management, recreation, non-wooden and new forest-based products, social and spiritual values;

   b)   the coverage of increasingly important topics such as carbon sequestration, bioenergy, remote sensing-based mensuration, ethics, or governance;

2) the loss of attractiveness of the profession, given:

   a)   the decline in enrolments experienced worldwide (Temu and Kiwia 2008);

   b)   the competition of related and emerging fields such as environmental sciences, natural resource management, and landscape ecology;

3) the need for modernising curricula, contents and services, which includes:

   a)   the effective change into a student-centred learning, with use of innovative pedagogical and teaching methods (instructional innovations);

   b)   the provision of a more engaging and integral study experience, with services and opportunities for personal development, and an improved study climate;

   c)   the need for bridging the gap between the competencies provided at universities and the needs of the employers (e.g. Forest Technology Platform 2005, European Commission 2006), including communication skills as well as skills for working in international, multicultural and multi-disciplinary environments;

4) the changing scenario in international higher education, which comprises:

   a)   a greater internationalisation of higher forestry education institutions, as well as the emergence of a great variety of degree programmes that attract foreign students;

   b)   greater opportunities for the mobility of students, faculty, and researchers;

   c)   restructuration of higher education systems, such as the European one through the Bologna process, and of universities' degree structures such as the Melbourne Model (University of Melbourne 2011).

The original motivation behind this research came during my work coordinating the M.Sc. European Forestry, a 2-year M.Sc. degree funded by the European Commission under the Erasmus Mundus programme. Given the changes occurring in the field, and the hundreds of applications that were received from B.Sc. forestry graduates from all parts of the world hoping to pursue a M.Sc., I was intrigued by their motivation and their views on forestry in general and forestry education in particular. Despite all the discussions taking place on these issues, the field of higher forestry education has seldom been researched. While educational scientists see the field as too specific and of relatively small importance in comparison to other disciplines, many forest scientists see the area as lying in the margins, if not outside, the discipline. Nonetheless, as stated by Zeegers (2001:2), "learning does not take place in a vacuum but is essentially content driven, and thus we would expect learning to vary according to the requirements of different disciplines". While research is certainly key to increased awareness on the issues affecting the field of forestry, an international perspective that includes student mobility is required to bring in a richer variety of perceptions and help developing the field.

International mobility in education is not a recent phenomenon. Examples from ancient times include, for example, the travelling of Greek scholars to Alexandria and Rome as early as during the fourth and third century B.C. (Jalowiecki and Gorzelak 2004). In forestry, numerous cases are found in the literature of foresters travelling abroad to teach or practice since the founding of forest science. Such foundation is generally attributed to the Germans Heinrich Cotta and Georg Ludwig Hartig, initiators, respectively, of the School of Tharandt in Saxony in 1816, and the School of Hunden in Hesse in 1789 (Ciancio and Nocentini 2000). Not surprisingly, a great number of these first forestry "international scholars" originated in Germany. Ribbentrop (1900) recounts with regard to the British rule of India, that "as Britain had no tradition of managing forests for sustained timber production, the forest department was started in India by German foresters". In fact, this purpose –the training of Indian Forest Service foresters- was the motivation behind the first formal forestry education established in England in 1885 by the German silviculturist William Schlich (Innes 2010).

In the last decades, the number of students that go abroad to further their education has grown considerably, with a 50 % increase in 2006 in relation to the year 2000 (OECD 2008). While no data exist for the field of forestry, increments in the number of foreign students have been experienced in many faculties of forestry and/or – as they are rebranding themselves – natural resource faculties, especially in North America, Australia and Europe. Such students represent a crucial intake of students at times when recruitment seems problematic. In Finland, for example, foreign graduates represented 25% of all graduates of the School of Forest Sciences of Joensuu as of the year 2010, while such figure was negligible before the year 2000. In non-English speaking countries, in order to increase the intake of foreign students, many European universities have switched the language of instruction to English, especially at the M.Sc. level (e.g. Wageningen University 2008).

The views that international M.Sc. students and domestic B.Sc. students have of forestry education was selected as the main focus for this study, complemented with an examination of the views from employers and universities. An in-depth analysis of few case studies, coupled with a survey study, was chosen as the most suitable approach given the great diversity of countries across the globe where forestry is taught. These studies provided abundant information which could not all be condensed in the 4 papers. Additional details are therefore included in this thesis.

1.1 Aims of the study

The main aim of this study was to explore the perceptions of higher forestry education from an international perspective, focussing on B.Sc. and M.Sc. level education as well as on employment prospects, by examining case studies in various countries across the world as well as employment issues in Europe. More specifically, the following research tasks were carried out:

1. To investigate the motivation of an international group of forestry students enrolled in a joint M.Sc. programme coordinated from Finland (paper I).
2. To examine the differences in the views of forestry students across the study years of a programme, taking as a case study a 5-year-long Brazilian B.Sc. programme (paper II).
3. To compare the perceptions of forestry students from three different continents, including motivational and developmental aspects, taking as case studies B.Sc. programmes from China, Finland and Brazil (paper IV).
4. To study the relevance of M.Sc.-level forestry competencies, examining and comparing the views from European universities and employers (paper III).

The selected case studies were: the M.Sc. European Forestry Erasmus Mundus (hereafter MScEF) co-organised by 6 European universities and coordinated by the University of Eastern Finland, and the forestry B.Sc. programmes provided by: the Federal University of Paraná in Curitiba, Brazil (UFPR), the Northwest A&F University in Yangling, Shaanxi province, China (NWAFU), and the University of Eastern Finland in Joensuu, Finland (UEF) (throughout this study, the terms Brazilian, Chinese and Finnish will be used to refer to the case studies of the universities UFPR, NWAFU and UEF).

The results of this research contribute to the work of higher education institutions, especially those in the forestry-related field, by obtaining a better understanding of the views of the students. In addition, the analysis of the European forestry graduate education and job market provides an insight for the related stakeholders, laying ground for the needed reforms.

2. THEORETICAL AND CONCEPTUAL BACKGROUND

Both educational and forest sciences were the focus of this research, therefore requiring a multi-disciplinary approach to examine forestry education with the use of tools from various other fields including sociology, psychology and economics. The following theories were considered based on their relevance to the subject of international forestry education.

2.1 General framework: input-output model, stakeholder, and institutional theories

The economic concept of productivity measures the output from a process in relation to the input. When applied to higher education, there are various inputs that can be considered in the process of the student's learning, such as students' motivation, values or prior knowledge. The importance of pre-university student characteristics has been found to have great influence in later professional success (Pascarella and Terenzini 1991). The process consists of the instructional model (i.e. lecturing, practical work, problem-based

learning…), the learning resources (materials, learning spaces…) and the learning tools (physical and cognitive tools). Finally, students' gains such as competencies and professional success will be the outputs of the learning/developmental process. This conceptual approach has been taken by Schomburg (1995) in the evaluation of higher education, as well as discussed by Enkenberg (2000) in the context of emerging teaching models, and later also adopted by Lewark (2001) in forestry education. From an educational perspective, the focus of this input-output learning model can be placed on the change of behaviour or quantitative growth of knowledge (behaviourism), on the mental processes (cognitivism), or on the individual's actions and thinking models (constructivism or socio-cultural conception of learning). Here the model is used as a framework for relating some of the theoretical aspects studied in this research: motivation, curriculum and competencies (Figure 1).

A second general theoretical framework considered in the study includes stakeholder and institutional theoretical considerations. Stakeholder theory, which originates as a management theory, examines the role of different actors in any given activity or process. According to the classical definition of Freeman (1984: 46), stakeholders are considered "any group or individual who can affect or is affected by the achievement of the organisation's objective". In the context of higher education, this definition has being refined by Amaral and Magalhães (2002:2) so as to include "any person or entity with legitimate interest in higher education and which, as such, acquires the right to intervene".

On the other hand, the considerations of institutional theory in higher education reflect the existence of similar educational structures (e.g. in terms of organisation and curricula) across different cultures, setting the ground for this comparative study in higher education. Despite the great differences across regions in the ecological, socio-economical and cultural conditions, educational systems can be considered fairly similar across countries (Meyer et al. 2007). These similarities occur, according to institutional theorists (e.g. DiMaggio and Powell 1983), due to pressures from widely accepted rules and beliefs over highly institutionalized organisations such as the University. On the institutional side, the particular characteristics of higher education and job market need to be considered.

INPUT		PROCESS		OUTPUT
Motivation		Instructional model		Competencies
Prior knowledge	→	Learning resources	→	Professional success
Norms (culture)		Learning tools		Relevance for society
Etc		(curriculum)		Etc
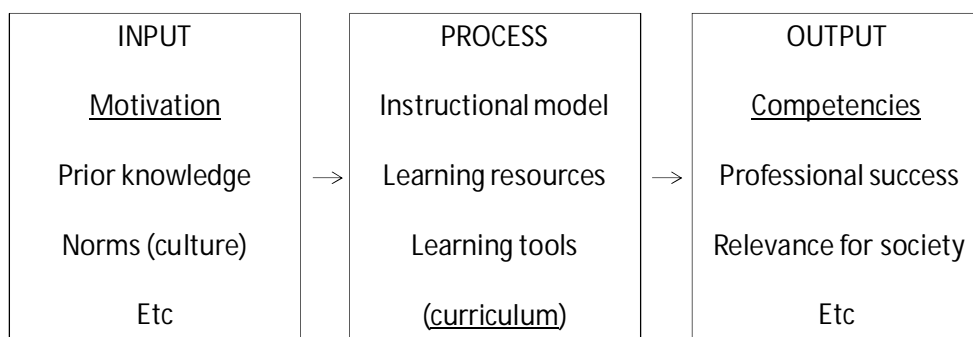
Figure 1. Conceptual input-output approach to higher education, modified from Schomburg (1995), Enkenberg (2000) and Lewark (2001). Elements emphasised in this study are underlined.
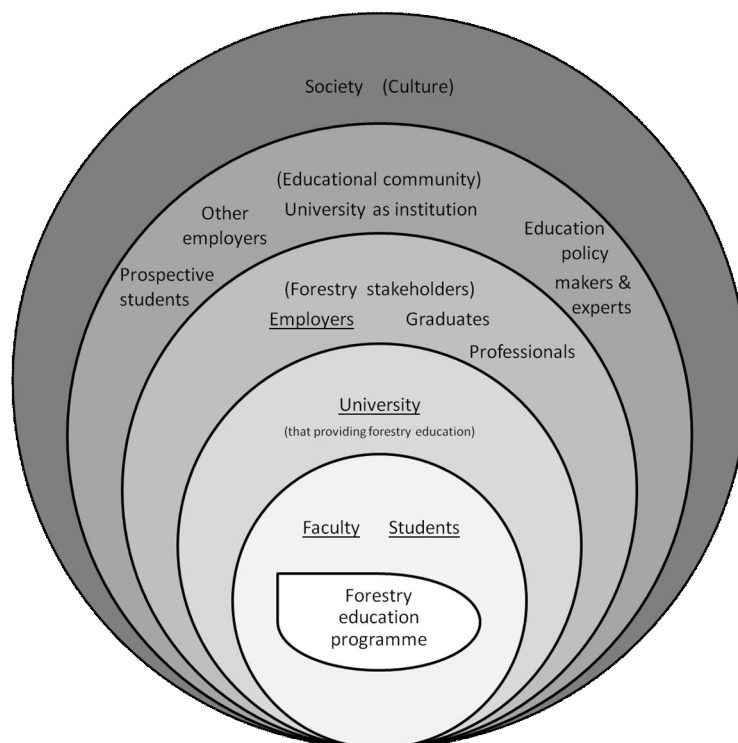
Figure 2. Relevant stakeholders represented according to their immediacy to forestry education programmes. Those considered in the study are underlined.

Additionally, any study dealing with perceptions across cultures need to regard the cultural differences affecting perceptions and their interpretations. For cultural considerations, and among a great body of literature (e.g. Schwartz and Bilsky 1987, Trompenaars 1993; the GLOBE Project -House et al. 2004), the most widely referred is the work on cultural dimensions by Hofstede (1991). The combination of elements from these theories in the study is presented in figure 2, where the most relevant aspects studied are underlined.

2.2. Competency approach

In recent years, a strong emphasis has been placed on the shift to a student-centred education. This shift implies that programmes and modules need to change their formulation from the traditional approach of learning inputs (what the student is taught, such as the length of the studies) to learning outcomes (what students actually learn) (e.g., European Qualifications Framework 2008). Learning outcomes are formulations of what a learner will know, understand and be able to do (usually defined with action verbs such as describe, analyse, identify) upon completion of the programme or module, which can be defined in terms of knowledge, skills and competencies (often also termed competences).

Whereas learning outcomes are the outputs of a module or course, competencies are those outputs of the learning process which are acquired by the learner. Although no consensus exists on a common terminology in relation to competencies, similar definitions have been proposed. For example, competencies have been defined as combinations of knowledge, skills and attitudes appropriate to the context (European Communities 2007). Also a competency has been defined as "the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development" (European Qualifications Framework 2008:4). These European definitions are in line with the OECD's Definition and Selection of Competencies Project, where competencies are said to be more than just knowledge and skills, "involving the ability to meet complex demands, by drawing on and mobilising psychosocial resources (including skills and attitudes) in a particular context" (OECD 2005:4).

However, there is no general agreement on how to classify competencies. Garcia-Aracil and Van der Velden (2008) provide a brief review of various classifications of competencies which include distinctions between: (1) general and firm-specific competencies, (2) specialised, methodological, participative and socio-individual competencies, and (3) competencies acquired in school of direct use in later work, those acquired in school that facilitate acquisition of new competencies after graduation, and those acquired mainly in a working context. Another common division is to consider subject-specific competencies on one hand and generic (or key) competencies on the other. Widespread work on the development of generic and subject-specific competencies for higher education programmes has been done for some disciplines at the European level (e.g., Gonzalez and Wagenaar 2003). However, only Schuck (2009) has focussed on forestry competencies in different countries, in her study across 8 European forestry faculties from four countries.

Some examples of defined competencies can help to illustrate these definitions and classifications. For example, Leeuwen et al. (2004:19) define, among the subject-specific competencies to be acquired by the graduate in a forest and nature conservation M.Sc. programme, that "the graduate in the role of researcher or advisor is able to integrate knowledge and development and can apply this on a strategic level for the analysis and the design of sustainable and ecological efficient management of forest and natural areas". With regards to the generic competency "ability to communicate effectively", the OECD's report (2005:4) explains that the competency draws on "the knowledge of language, practical IT skills and attitudes towards those with whom he or she is communicating". Because of the complexity of defining competencies, they have often been simplified to shorter formulations as individual skills or subject areas.

2.3. Motivation theory

The reasons that motivate students to enrol in forestry studies, to choose a given programme and to learn specific subjects have a great importance. Motivation can be defined as the internal state or condition that serves to activate or energize behaviour and give it direction (Kleinginna and Kleinginna 1981). Research shows that motivation is a key issue for learning and success, enhancing content understanding and skill capabilities and leading to achievement (e.g. Blumenfeld et al. 2006). Benefits of an increased awareness of students' motivation have been reported, for example, by Jenkins (2001), as it helps curriculum developers and instructors to design more effective learning environments

and student support systems. While few studies have been published on motivation at a discipline level (e.g. Ribchester and Mitchell 2004, in geography) or considered multicultural groups (e.g. Lavery 1999, with Pakeha, Maori, Pacific Islands and Chinese students in New Zealand), these have not included forestry.

Among the different theories that coexist in the field of motivation, cognitive approaches emphasise students' goals, plans and expectations (Schunk 2004). These cognitive theories of motivation assume that behaviour is directed as a result of active processing and interpretation of information such as their beliefs and interpretation of their experiences. Within this approach, the expectancy-value theory considers that student's motivation can be explained by their beliefs about how well they will do in an activity and how much they value it (Feather 1982, Pintrich 1989, Wigfield and Eccles 2000). Self-efficacy, the self-judgment of one's ability to perform a task in a specific domain, affects motivation by influencing the expectancy for success (Bandura 1982, 1994).

In this context, three types of motives – intrinsic, extrinsic and achievement – can be distinguished. Intrinsic motivation is the engagement in actions for their own sake with the only tangible benefit being outcomes such as pleasure, learning, satisfaction, interest or challenge (Alderman 1999). In extrinsic motivation, the purpose is attaining rewards such as praise or high grades (Alderman 1999). Achievement motivation is defined as the pattern of planning, of actions and of feelings connected with striving to achieve some internalized standard of excellence (Vidler 1977). These aspects of motivation were selected to explore the motivation of international students for enrolling in M.Sc. studies, as well as considered in the study of the motivation of domestic B.Sc. forestry students in the selected case studies. The motivation framework is shown in figure 3.
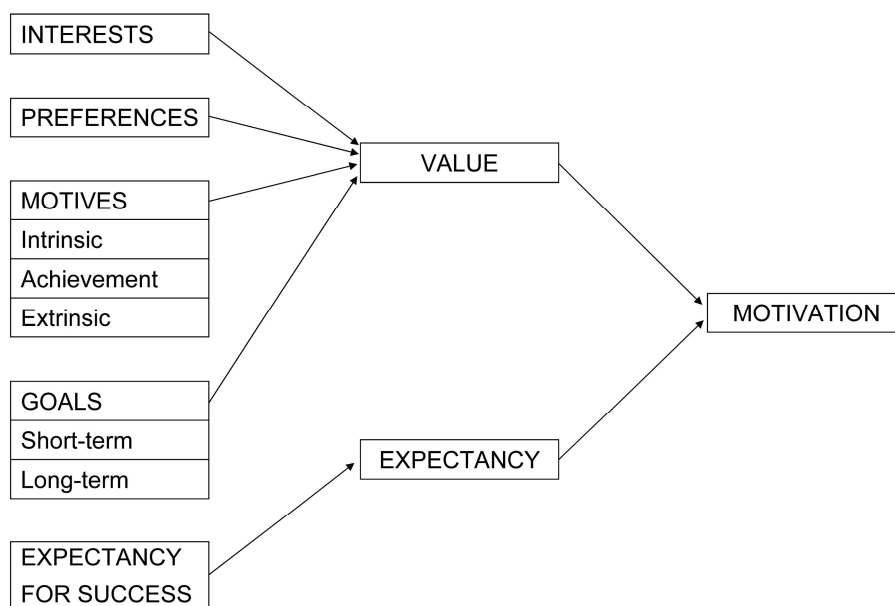
Figure 3. Expectancy-value theory of motivation, with the motivational aspects investigated in this study indicated on the left.

2.4 Experience, expertise and student development

In addition to competencies, the experiences that students have (defined by Anderson (2006) as the accumulation of knowledge or skill that result from direct participation in events or activities) are receiving increasing attention within the education community. Experiences are considered to be a crucial part in the study of student engagement, in turn defined as students' active participation in the learning process in reference to their involvement with activities and conditions (both academic and non-academic) that generate high-quality learning (Australian Council for Educational Research 2008). A greater engagement of students in challenging learning environments has been reported to improve general education knowledge and practical competencies (Umbach and Wawrzynski 2005).

   Additionally, students' perceptions regarding their education are likely to change over the course of their studies. Changes have been previously investigated with students of other disciplines such as psychology (e.g., Radford and Holdstock 1993, Jacobs and Newstead 2000). The progression of a student through a study programme can be understood as a form of expertise development. Thus, more knowledgeable individuals can be considered experts in relation to those less knowledgeable (Chi 2006). A gradient of expertise has been proposed by Chi of novices in a first stage, then initiates, apprentices, journeymen and then experts, with full expertise reached after 5-10 years of professional practice and development.

3. BACKGROUND FOR PAPERS

Background information related to the study is presented in this section in a progression from local to global perspectives. Thus, background on the study cases of Brazil, China and Finland are first introduced (relevant for papers II and IV), followed by an analysis of the European and international contexts and the job market (relevant for papers I and III).

3.1 Forestry education in Brazil, China and Finland

Forestry education in Brazil

The history of Brazilian forestry higher education goes back to 1960, when the first programme was set up in Viçosa (state of Minas Gerais) and three years later moved to Curitiba (state of Paraná), where the first group of students graduated from the UFPR. In this sense, this case study university is not only the oldest in Brazil but also the oldest of all Latin-American universities that offer forestry. Since then, but especially within the last 15 years, forestry higher education has rapidly expanded with a large number of public and private programmes offered throughout Brazil. Nowadays, up to 57 other institutions in Brazil are offering a B.Sc. in forestry, most of which offer a 5-year education (SBEF 2009). Even though a law from 1996 requires the adaptation of the programmes to new curricula guidelines (LDB 1996), many of the degree programmes have not yet undergone these reforms. Such was the case in the selected case study where the latest curriculum reform dates from 1991 (UFPR 2006). A particular aspect of this B.Sc. programme is that within its first year, the curriculum puts emphasis in core engineering disciplines including courses

Figure 4. Brazilian forestry students from UFPR during two moments of a lesson on the use of the chainsaw: in-class instructions (left) and practical instruction (right) [Photos: Javier Arevalo].

such as geometry and technical design, calculus and algebra, or physics, barely touching any aspect of forestry.

In Brazil, both the number of graduates as well as the jobs in forestry increased at an average rate of over 10% annually, showing the current expansion of the sector (FAO 2010a). The high number of universities that provide forestry education in Brazil is justified by the great importance of the forestry sector at national and international levels. With over 477 million hectares of forest, Brazil has 12% of the world's total forest area, only surpassed by Russia as the most forested country in the world (FAO 2009). Brazil is one of the most important emerging economies and a leader in high-productivity plantation forestry. The role of forests in the development of the Brazilian economy is increasingly important in terms of both production and conservation. The production-conservation balance in the Amazon region is an issue highly debated not only in Brazil but internationally, as reflected by the reactions to the 2006 Public Forest Management Law – which allows new concessions in the Amazon – and to the constitution of the Amazon Fund in 2008 as an international conservation fundraising initiative.

Forestry education in China

China's forestry education has been subject to the changes related to the political situation, policy context and institutional reform. According to the State Forestry Administration (SFA 2010), before the foundation of the People's Republic in 1949 there were 21 universities and agricultural colleges that had a forest department. Within the following years, and according to the same source, the government paid great attention to forestry education, with special forestry courses starting at various universities and colleges. This development was coupled with a great effort of reforestation launched in 1956 (Ehrenreich 1980). Forests and forestry education, however, suffered considerable harm during the Cultural Revolution (1966-1976). As described by Primack (1988) in his article *Forestry during the Cultural Revolution*, officers of the forest departments as well as the professors of forestry colleges were not exempted from the excesses of the Red Guard, accused of

Figure 5. NWAFU forestry students' graduation picture (spring 2010) [Photo: Huang Yan].

promoting capitalistic and bourgeois values over the original ideas of communism. Thus during this period, extensive illegal logging took place as forest officers lost control over the management, while colleges were disbanded and later reopened with curricula written by students along the values of the Revolution.

After such troubled period, normality returned to forestry education. By 1980, forestry education included 3 major colleges (Beijing, Nanjing and Northeast) and 22 provincial colleges and departments within agricultural colleges (Ehrenreich 1980). Today, and despite the reported decrease in the production of goods (FAO 2010b), which can be explained on one hand by the partial ban on logging imposed in the 1990s, and on the other by the migration from the country to the cities, the sector´s outlook is of clear expansion. In addition to programmes related to renewable energies and climate change impact mitigation, large investments in forestry are being made through six major programmes, such as the Three North Shelter Belt afforestation programme of desertification and erosion control in the Loess plateau (Wang et al. 2008).

At the end of the last century, President Jiang Zemin's speech commemorating the 100th anniversary of Beijing University was a milestone of China's higher education policy, which has been reflected in the change over the last decade. Zhang (2010) identifies the following as the main significant changes in Chinese forestry education: rapid growth in enrolments (from 12 000 in 1998 to 56 000 in 2008); fast growth in both M.Sc. and Ph.D. education and joint education with foreign universities; and merging of colleges as well as transformation of traditional forestry universities and colleges into more comprehensive institutions (which may now include majors as diverse as art or economics). According to the website study-in-China.org (2011), there are currently 26 universities providing a major in forestry. Still a characteristic of Chinese forestry education is that is often taught in single-disciplinary universities, usually agriculture and/or forestry universities, which may give a narrower perspective to students (Yin 2010). Also the introduction of English as a language of instruction (either by foreign teachers, or by Chinese teachers with use of Chinese as supporting language in a mode locally known as "bilingual teaching") is gaining pace thanks to the government promotion.

In Yangling, the College of Forestry of the Northwest A&F University originates in the forestry group of the National Northwest Junior College of Agriculture and Forestry established in 1934, with the Northwest College of Forestry being formally established in 1979. The College of Forestry provides 4 undergraduate, 9 master and 7 doctoral programmes, which majors are not only forestry but also other disciplines such as artistic design and gardening and floriculture. The College provides also adult education programmes, and is very active in research (with 5 research institutes and 5 scientific innovation platforms under the College), extension projects, and international cooperation. The 4-year B.Sc. programme in forestry was last reformed in 2008. Stimulated by the new ministerial policy, the College of Forestry will significantly expand the admission of adult students in Professional Master Programmes in the next five years, with the number of adult students to equal the number of other M.Sc. students on campus.

Forestry education in Finland

According to the Finnish Forest Association (2011), the teaching of forestry in Finland began in 1862, although a doctoral thesis dealing with trees was already defended in 1772 at the University of Turku. Nowadays, two types of higher education institutions provide forestry education in Finland: these are on one hand the universities of applied sciences (also known as polytechnics, which can only offer B.Sc. and M.Sc. level education), and on the other hand the "traditional" universities providing all levels of higher education including Ph.D. These "traditional" universities are the University of Helsinki (whose Faculty of Agriculture and Forestry dates from 1924), and the University of Eastern Finland (whose School of Forest Sciences – formerly Faculty of Forestry of the University of Joensuu – was founded in 1982).

Within the last decade, the number of applicants for forestry, woodworking and paper industry education in Finland has dramatically decreased, although this phenomenon has mainly affected the vocational and applied science universities, and to a less extent the traditional universities (Finnish Forest Industries Federation 2010). Nonetheless, the stagnation in the graduate numbers as well as in employment in primary forestry production reflects the difficulties of the sector in relation to recruiting students and to the struggle of its traditionally strong pulp and paper sector. In the case of the wood products industry, a poor visibility in the form of unfamiliarity and unawareness of the opportunities to study the field among young people has been identified as a major reason for the decline in enrolments (Mynttinen 2009). According to Hetemäki (2009), the changes in the Finnish forest industry are due to three main factors: increasing globalisation and competition with production from countries where production costs are lower, the development of new technologies, and the reduction of the relative importance of the forest industry due to the diversification of the Finnish economy with rising areas as electronics and services. It is expected that the Finnish forest sector will face severe challenges during the next decades due to globalisation, constant increase in society's demands for sustainable development, and aging population (Niskanen 2006).

Figure 6. Finnish forestry students from UEF organising traditional annual events: the dipping of first year students in the icy river (left), and a 12-hour skiing competition (right) and [Photos: forestry students' association Joensuun Metsäylioppilaat].

For Pettenella and colleagues (2010), Finland is – together with other Nordic countries of Denmark, and Sweden – one of leading countries in the process of European integration in forestry education. This international recognition is to a large extent a consequence of the important number of international projects led by another of the chosen case study universities: the University of Eastern Finland, and within it, the School of Forest Sciences of the Faculty of Science and Forestry. These international tasks include the presidency of the SILVA Network (European Academic Network for Forest Sciences; 1996-2008), the co-secretariat of the International Partnership for Forestry Education (since 2008), the development of forestry curricula in various countries (e.g. Moi University, Kenya), or the coordination of the Erasmus Mundus M.Sc. European Forestry and the Cross-Border University M.Sc. Forestry and Environmental Engineering (since 2004 and 2008, respectively).

Also adding to the traditional role of the School of Forest Sciences for doing research and educating Finnish foresters, an important flow of international students and scholars has been attracted to Joensuu within the last few years. As of the academic year 2010/2011, the number of foreign students enrolled at the School amounts for about 90 exchange students, 20 M.Sc. students (40% of the total M.Sc. students), and 20 Ph.D. students (60% of the total Ph.D. students). These figures show the attractiveness of Finnish forestry education in the international context, moreover when it is considered that no significant international marketing efforts have been made. However, lately, some attention has also been paid to a potentially significant area of development in higher education: the provision of professional training courses (i.e., continuing education), concretely through the provision of the 2-week foreign module the mid-career Indian Forest Service Officers funded by the Government of India.

Key comparative aspects of forestry education in the three selected universities

There were various similarities with regard to the type of forestry education offered at the three selected universities, such as the public nature of the institutions, the relatively similar number of forestry students, and their provision of a generic forestry B.Sc. degree

programme aimed at national students and delivered in the respective national language. There was, however, a major difference with regard to the length of the studies and the time of the last curriculum reform: UFPR offered a 5-year B.Sc. programme (with the last curriculum reform dating from 1991), NWAFU provided a 4-year B.Sc. degree (last reformed in 2008), while UEF provided a 3-year B.Sc. degree which was reformed in 2007 (substituting the previous long-cycle 5 year M.Sc., following the B.Sc.-M.Sc. structural reform demanded by the Bologna Process of reform of European Higher Education). Key figures regarding the 3 B.Sc. case studies are shown in table 1 (further details are provided in an expanded table 3 in paper IV).

Different conditions existed in the three case studies with regard to access and cost of the studies. While access to the studies is in all cases regulated by entrance examinations, these are carried out at faculty level in the Finnish case, university level in the Brazilian case, and national level in the Chinese case. These differences have important implications, as elaborated further on, given their influence on the type and profile of student that accesses the profession, as well as their motivation.

Thus, in the Finnish case, each faculty organises a different entrance examination for its prospective B.Sc. students, with students undertaking various entrance examinations in different disciplines if they wish (if the student is accepted in more than one, he/she is able to decide later on). In the case of Joensuu (Finland), the profile of the student can be considered as of relatively interested in forestry and coming either from the Joensuu region or from other rural areas of the country. Given that the offer and demand of study places is relatively balanced, the competition for entering the faculty can be considered as relatively undemanding, with students typically being accepted right after completion of high school. With regard to the costs of studying, no study fees are charged in Finland for national or European Union nationals (with fees for non-EU nationals introduced in some studies in 2010 under a pilot programme), with an average price of student housing (in a typical 3-

Table 1. Key figures of the selected universities. Data: (1) FAO 2010a/b/c, (2) Lebedys 2004, (3) University webpages, documents and personal communications, (4) Brazilian Geographical & Statistical Institute (2000), Statistics Finland (2008), Statistics China (2010).

Background data (country level)	UFPR Brazil	UEF Finland	NWAFU China
Forest area 1 000 ha / for. area change [1]	519 522 / -0.6%	22 157 / 0%	206 860 / +2.2%
For. area % / for. area per capita (ha) [1]	57% / 1.1	74% / 4.3	21% / 0.36
Contribution of forestry sector to GDP [2]	4.1%	7.5%	1.7%
Number of universities offering forestry [3]	58	2	26
Background data (university level)			
Location (population) [4]	Curitiba (1 587 315)	Joensuu (72 433)	Yangling (155 000)
University students / staff [3]	30 771 / 3 704	14 000 / 2 900	27 100 / 4 689
Type of forestry unit [3]	Department	School	College
Forestry BSc/MSc/PhD degrees offered [3]	1 / 5 / 1	1 / 3 / 1	1 / 3 / 3
Number of forestry students [3]	500	400	550

room flat) of about 200-250 EUR. Government support for students of higher education amounts for 300 EUR a month, plus 80% of the accommodation costs (with an upper limit of 200 EUR) for those living outside their parents' home, allowing students to cover most of the costs during the studies, sometimes supplemented with a summer job or a parental allowance.

In the Brazilian case, the entrance examination (*vestibular*) is organised at the level of the university. Because UFPR is regarded as one of the best public universities in Brazil, and Curitiba one of the most attractive cities, demand for entering the university is high, with students typically preparing for it during 1-3 years. Within the university, allocation to faculties is done according to marks, with forestry being relatively demanded although not among the top choices (these are in studies such as medicine, architecture, or civil engineering). Given the public character of the university, no tuition fees are applied. Living expenses can be estimated to about 800 Brazilian real (about 350 EUR) per month, with half of the amount needed for accommodation (no student housing is offered by the university). In the case of forestry students of UFPR, there is a large mixture of backgrounds, with students mostly originating in Paraná or surrounding states, and with presence of students from both urban and rural backgrounds. Because of the access system, students who only chose forestry as a second, third or even later option could be found in the surveyed group.

In the Chinese case, a national examination regulates the entrance to universities, which is typically prepared during one year. The asymmetry of the Chinese higher education system is here evident: forestry studies are offered in forestry and/or agricultural universities (e.g. Beijing Forestry University, though these universities can also offer a great number of subjects) as well as in comprehensive universities. The selected Chinese study case, NWAFU, is a key university under the jurisdiction of the Chinese Ministry of Education, a status that confers it a high prestige. With regard to its location, it sits in a small town within a rural area near the city of Xi'an. Because the choice of major is only made after acceptance of the study place at the university, many students were satisfied to be accepted at the university but disappointed for not being accepted to the studies they wished. With students originating from all over China, a slight majority had a rural background and were originating from the same area of the university (Shaanxi province, northwest China). With regards to the cost of studying, fees amount for about 3 000 yuan per year (330 EUR), with additional 1 000 yuan (110 EUR) for the mandatory in-campus accommodation (typically in dormitories with 6-bed rooms). Various forms of financial assistance in the form of loans, as well as subsidies for students from low-income backgrounds are available.

3.2 European and international perspectives of forestry education and job market

European perspectives

The Bologna Process, which aims at the establishment of a common European Higher Education Area (Bologna Declaration 1999), has been an important vector of change in European forestry education within the last years. This process puts emphasis on issues such as quality assurance, recognition of qualifications and periods of study, student-centred approach, teaching of skills and competencies, employability, mobility, and life-long learning. As a consequence of these reforms, a structure of B.Sc. and M.Sc. degrees

has been created in many European countries which did not exist previously in forestry (e.g. Finland and Germany). Another important vector of change has been the competition for attracting foreign students, with a great number of international study programmes having been created in recent years.

Within Europe, there is an overwhelming dominance in foreign student intake of UK, Germany and France, with three out of five foreign students choosing to attend an institution in one of these three countries (UNESCO 2005). While specific figures for forestry do not exist, some particular factors are levelling the playing field, with some 7 countries most likely being the major recipients of forestry students. These factors are the tradition of forestry teaching (especially Germany), the current importance of the forestry sector (France, Sweden and Finland), and the international orientation given to forestry studies (the Netherlands, Denmark, the UK). Outside English-speaking countries, and very prominently in Europe, these international programmes are increasingly using English as a language of instruction in order to promote their attractiveness among foreign students. This is mostly occurring at the M.Sc. level, as well as rapidly expanding to Ph.D. level, with B.Sc. programmes still mostly offered in the national language. Among the variety of international M.Sc. forestry programmes created within the last decade, double and joint-degree programmes (which offer upon graduation, a degree that is jointly recognised by two o more co-organising institutions) are seen as important achievements of internationalisation due to the high level of cooperation required in its organisation.

In Europe, in 2004 the European Commission launched the Erasmus Mundus programme in order to promote the development of such joint programmes, originally within European higher education institutions, and since 2009 opening its co-organisation to institutions outside Europe. The generous funding offered by the Commission can be seen as the incentive for European institutions to establish closer cooperation, given that the EU has a low level of competence in the field of education and cannot therefore establish a European degree. Thus, Erasmus Mundus (the global version of the intra-European "Erasmus" mobility programme) can be considered the international flagship of the Bologna reform process, aiming at enabling the EU to compete against the US and other international major players in education. A geographical distribution clause given by the Erasmus Mundus programme, which limits the number of scholarship recipients from each country to 2, is responsible for the great variety of nationalities present in such courses. During the first phase of the Erasmus Mundus programme (2004-2009), when data for paper I was collected, no scholarships were awarded to European nationals, which also explained – at least partly – the much lower presence of European students in the programme. Scholarship for Europeans has now been introduced in the second (2009-2013) phase of the Erasmus Mundus programme.

The M.Sc. European Forestry Erasmus Mundus, selected as the case study in paper I, is the oldest of the three Erasmus Mundus M.Sc. programmes that are currently offered in the field of forestry. Coordinated by the University of Eastern Finland, the MScEF is a double-degree programme co-organised together with 5 other institutions (University of Freiburg in Germany, Swedish University of Agricultural Sciences in Sweden, University of Lleida in Spain, Wageningen University in the Netherlands, University of Natural Resources and Applied Life Sciences Vienna in Austria; and with a seventh partner university since the addition in 2010 of AgroParistech-ENGREF). It consists of a first year of common courses in all different co-organising universities (a month in Sweden, 2 and a half months of traineeship, 4 months in Finland, a 4-week field course in Spain, France, Germany and the Netherlands with one week in each of the countries, and 2 weeks in Austria). The second

year of studies takes place at one or two of the organising universities, with students obtaining their double degree from Finland and the corresponding second year university.

International perspectives

Verbik and Lasanowski (2007) categorised the main countries with respect to inward international of mobility of students as "Major Players" (the United States, the United Kingdom and Australia), "Middle Powers" (Germany and France) and "Evolving Destinations" (Japan, Canada and New Zealand). In addition, China can be seen as a likely candidate for joining these main receiving countries in the near future, given the effort that is been put into attracting foreign students. In this sense, in 2006 the Chinese government initiated a programme of scholarships for B.Sc., M.Sc. and Ph.D. foreign students, which had reached over 20 000 recipients – a great number of them coming from African countries – by 2010.

According to FAO (2009), more than 60 000 university students graduate in forestry annually. A more enlightening global figure is one referring to the global decline in enrolments, estimated at around 30%, and which mainly affects Europe and Africa (Temu and Kiwia 2008). Such decline has also been reported in countries such as UK, Australia and Canada, with a global trend in forestry faculties of responding to this by amalgamating with other faculties (Innes 2010). In the US, Yearout and Straka (2010) also report that numerous forestry programmes have merged with or moved into broader departments, schools and colleges.

In order to respond to the increasingly tough competition for international forestry students, many universities are embarking in innovative education initiatives. Some examples are the 2+2 programmes between Canadian universities (University of British Columbia and Alberta) and China, and the offer of online degrees such as those from Oregon and Mississippi State universities in the US. In Australia, along the lines of the joint Erasmus Mundus programmes of Europe, the National Forestry Masters Program allows for enrolling and choosing studies from the offer of 5 partner universities. Other internationalisation modes such as the provision of forestry education in an off-shore campus have not yet been reported in the forestry field.

Job market considerations

The needs of the professional forester job market with regard to the forest sector are changing, with shifting demands of society with respect to the forests and their utilisation being among the main causes. FAO's State of the World Forests 2010 provides some relevant figures on employment. Thus, around 10 million people were employed in forest management and conservation. However, employment in forest establishment, management and use declined in 10% in the period 1990-2005, which is attributed to gains in productivity. On the other hand, employment in management of protected areas increased in most countries, though there was a reported decline of 1.2% annually since 2000 in the number of staff working in public forest institutions. With regard to Brazil, China and Finland, the number of jobs in the management of protected areas showed a considerable annual increment (over 10% annually) in the three countries (FAO 2010a,b,c). Nonetheless, the increasing diversity of job placements taken by forestry graduates in other related and non-related fields adds complexity to job market studies, as there are no longer a small number of major employers in each country.

In Europe, the need for universities to overcome mismatches between competencies acquired during studies and market needs has also been stressed within the European Union's education agenda (European Commission 2006). Also the difficulties of professional foresters with regard to dealing with public relations and communication have been pointed out, with a recent EU-funded project (PAWS 2004-2007) targeting pedagogical abilities of forestry professionals. With regard to employment figures, European data shows that employment in its forest sector continues to decline at a rate of 1.6% per year since 2000 (MCPFE 2007). According to the same source, an increasing proportion of employees in the forest sector in Europe hold a university degree, while those who suffer most from job losses are the less qualified workers. Yet the employment situation of university degree holders varies greatly across countries, with no existing standardised data available.

4. MATERIAL AND METHODS

4.1 Thesis framework

A mixed methods strategy was adopted in this study. Mixed methods strategies can be defined as a type of research design in which qualitative and quantitative approaches are mixed across the stages of the study (Bryman 2004). From a methodological point of view, the study built on an interaction of both survey research and case study research, which were the research designs used in the four different papers. Survey research was used in paper III from the approach of a structured, research-defined representation of a phenomenon (the views of European employers and universities of the job market for M.Sc. forestry graduates), in which results could be somewhat generalizable and describe patterns. Case study research, which provides a contextual representation of the phenomenon through the in-depth examination, was used in the characterisation of the views of the students from four concrete study programmes: an international M.Sc. and three national B.Sc. programmes [the three case studies of B.Sc. programmes can also be understood, in line with Stake (1995), as a collective case study]. The selection of case studies was influenced by a combination of opportunity and a concern for geographical representation (selecting cases in three different continents, in addition to the international M.Sc.).

   Two major factors influenced the choice of case studies. One was the partnership of the three universities in the Erasmus Mundus M.Sc. European Forestry, which facilitated the contacts and cooperation as well as funding for the research visits. The second was the existence of similarities with regard to the type of forestry education at the three universities, as there were public universities, had a relatively similar number of forestry students, and provided a generic forestry B.Sc. degree programme aimed at national students, delivered in the respective national language. The targeted stakeholders and geographical span of the study is represented in figure 7.
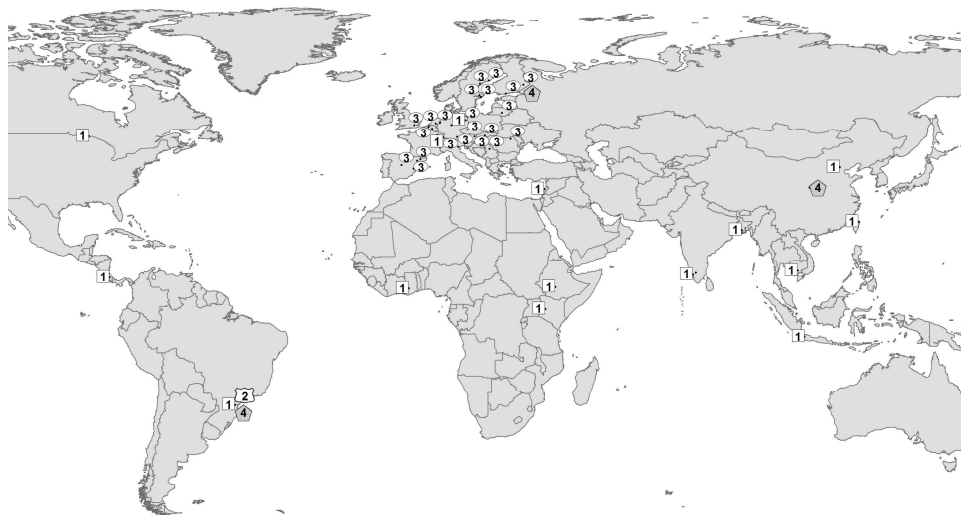
Figure 7. Outline of the thesis framework, with indication of the targeted respondents and the place of data collection in the each of the four papers.

With regard to the data collection methods, paper I is based on qualitative data obtained through in-depth interviews. Papers II, III and IV are largely based on quantitative data complemented by qualitative data in the form of a few open-ended questions. Data from these open-ended questions was mostly quantized, i.e. converted to numerical codes for frequency or statistical analysis (Miles and Huberman 1994). Data for papers II and IV was collected through the administration to students of three versions of a questionnaire, translated to the corresponding national language. Data for paper III was collected through two versions – one for employers and another for universities – of a similar questionnaire, written in English. The geographical scope of the data used is shown in figure 8. Further details of the material and methods used in each paper are given in the next chapters.
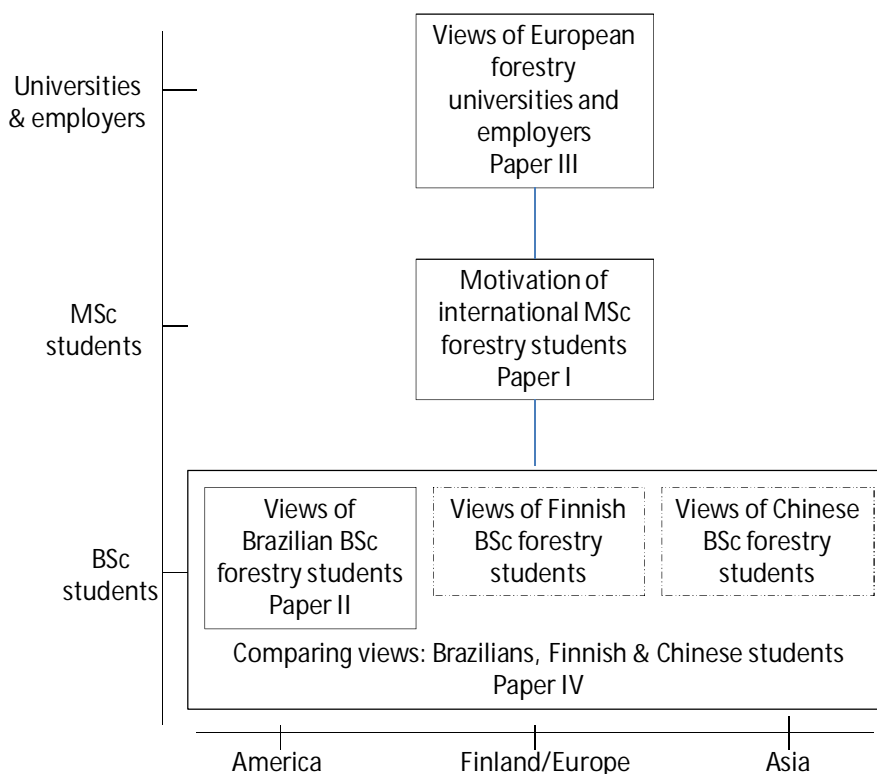
Figure 8. Map outlining the geographical origin of the students, employers and universities surveyed in this study. Places of origin of the 20 international students interviewed in paper I are marked with the number 1. Number 2 indicates the location of UFPR in Brazil (where the study leading to the paper II was carried out); while number 4 indicates the location of the universities selected as the three case studies compared in paper IV (UEF in Finland and NWAFU in China, in addition to UFPR in Brazil). Number 3 indicates the location of the employers and universities surveyed in paper III (due to the scale of the map, not all locations are displayed; a complete list can be found at the annex II of paper III).

4.2 Material and methods in paper I

The participants of the first study were 20 students starting their M.Sc. European Forestry Erasmus Mundus studies. The students' average age was 25 years (ranging from 21 to 30 years old), 13 males and 7 females. A majority (14) of the students had a B.Sc. in forestry, one already had a forestry M.Sc., while the remaining 5 had completed other types of higher degrees either in forestry or agriculture. Students were from 14 different countries, with non-European students receiving a full-time scholarship provided by the European Union's Erasmus Mundus programme. Data was collected through face to face semi-structured interviews with each of the students within the first week of their study programme. The length of the interviews was 42 minutes on average and included open-ended questions on the 5 motivational aspects presented in the previously described

theoretical framework: students' interests, preferences, motives, goals, and expectancy for success. Interviews were conducted in English, except for one interview which was conducted in Spanish (being the mother tongue of both the interviewer and the interviewee). The interviews were audio taped and later transcribed. A meaning condensation analysis was carried out to explore the variability of answers in each motivational aspect. Answers were categorized followed by quantitative content analyses and frequency analysis. Qualitative content analyses (Kvale 1996) and the selection of excerpts in order to show students´ responses in their own words completed the data analysis.

4.3 Material and methods in paper II

A total of 268 students, all Brazilian nationals, participated in the second study. Respondents had an average age of 21.3 years, with 52% of them being female. From first to fifth year respectively, the number of respondents was 67, 55, 46, 52 and 48, corresponding to 96, 82, 66, 65 and 71% of the registered students in each year. A combined quantitative and qualitative approach was taken in this study. The main data collection instrument was a three-part questionnaire. Closed-ended Likert-type questions were included in the first part of the questionnaire to obtain a numerical evaluation of the importance that students give to a list of competencies (both subject-related and generic) and experiences. This part of the questionnaire was partly inspired by those used by Radford and Holdstock (1993) and Jacobs and Newstead (2000) for psychology students, who distinguished between categories of knowledge, skills and experiences. Some items were added, including four items that were inspired by the European standards for M.Sc. level studies (Dublin descriptors 2004, European Qualifications Framework 2008). Other changes and additions were made in consideration of the previous work done by Schuck (2009) with subject-specific competencies in forestry, and the generic competencies used by Gonzalez and Wagenaar (2003) and Garcia-Aracil and Van der Velden (2008).

The resulting 39 items (13 subject-specific competencies, 13 generic competencies and 13 experience items, which are listed as an appendix in paper II) sought to represent competencies and experiences of a generic higher forestry degree programme, and were randomly ordered in the questionnaire. The importance of each of the items in the questionnaire was asked from students in a scale from 1 (of little importance) to 5 (extremely important). The second part of the questionnaire consisted of open-ended questions on the students' forestry concerns at national and global levels, while the third part consisted of closed-ended questions on students' future plans and preferences with regards to work and future studies. This included evaluations of their satisfaction with the studies and self-reported grades [from "well-below average (1)" to "well above average (5)"]. The questionnaires, in Portuguese and in paper form, were administered in the beginning of regular lectures (in a common compulsory discipline for each study year) during the second month of the academic year in 2009.

Since the aim of the study was to explore general trends with regard to changes across study years rather than year-to-year variations, responses were grouped according to three groups: first-year students, middle-years students (second- and third-year students), and final-years students (fourth- and fifth-year students). Likert-type items were statistically examined with One-Way ANOVA for differences among groups across study years. In the cases of significant differences between study years, Tukey's Post Hoc Multiple

comparisons test was used to determine which groups were different. Answers to open-ended questions on forestry concerns were subjected to a meaning condensation analysis and coded to explore the variability of answers and build categories, followed by frequency analysis. Closed-ended questions were subjected to frequency analysis. In the last two cases, Chi-Square test was used following the frequency analyses to examine differences across study years.

4.4 Material and methods in paper III

For this survey study, coordinators of 82 M.Sc. programmes from 72 universities in 35 European countries were contacted. Their contact information was obtained by using the databases of the European Forest Institute's Euroforest Portal (http://forestportal.efi.int) and the SILVA Network (www.silva-network.eu), and complemented with an internet search. 25 universities from 13 countries across Europe, including four cross-national consortia, responded to the survey, i.e. a 30% response rate. Ten of the programmes were international, in the sense that they had a significant proportion (over 25%) of foreign students. 64 employers were contacted through information provided by the M.Sc. coordinators, obtaining 18 responses (a 28% response rate). Two similar online questionnaires, one targeting employers and the other one targeting universities, were designed, both in English language. The questionnaires included a short introduction stating who were the targets of the study. In the case of the questionnaire for universities, this read:

"This survey is targeted at the programme coordinators of forestry Master programmes in Europe, including Russia. [With forestry we refer to the study of forests, trees and their management and utilisation considered in a broad sense (i.e. including programmes that deal with any such areas as forest policy, planning, growth, technology, ecology, protection etc) but excluding highly specialised programmes in the areas of pulp and paper and wood products. With Master programmes we refer to higher education programmes that correspond to Bologna's second cycle (level 7 of the European Qualifications Framework) which upon completion qualify graduates for entering into Doctoral programmes. Programme coordinators of long cycle degrees not yet adapted to Bologna that qualify their graduates for enrolling in doctoral studies are therefore also included.]."

The questionnaires had three sections, dealing respectively with profile data, general views on employment, and competencies. A total of 42 competencies, 21 subject-specific and 21 generic, were included. The competencies, aiming at representing competencies of a general graduate forestry degree programmes, were modified from those used in study II, expanding on the subject-specific and generic competency items while not including the experience items. Two questions were posed to employers and universities regarding each of the 42 listed competencies: (1) to rate the importance of the competency for the employment of graduates [on a scale from very little importance (1) to very high importance (5)]; and (2), to rate the level of development achieved in the competency by current graduates [(from very little development/achievement (1) to very high development/achievement (5)]. The gap in present-day education was estimated from the difference between importance and achievement values. Mean values were calculated for the competencies' importance, achievement and gap level. The Mann Whitney U test was used to analyse differences between universities and employers.

4.5 Material and methods in paper IV

Responses from B.Sc. forestry students from the Chinese and Finnish case studies were gathered during spring 2010, and added to the data from the Brazilian students collected a year earlier (spring 2009). Altogether, the views of 584 students were analysed. The age of respondents was 21 years old on average (average of 21.3 for UFPR, 21.3 for UEF, and 21.4 NWAFU). The ratio of female respondents was 47% (52% at UFPR, 33% at UEF, and 46% at NWAFU). Response rates ranged from 65% to 98%, depending on the study year and university, in relation to the total number of registered students. The questionnaire was a similar version, translated from English into the respective national language, of the one designed in the previous study (paper II). Although no back-translation was done, each translation involved the participation of two independent persons. Questionnaires were administered in paper form during class in all cases except for the final year students from UEF and NWAFU, who by then were not attending any courses (only doing their thesis), and for who a course representative distributed and later collected the questionnaires. The questionnaire data was supplemented by curriculum information, relevant literature, and with interviews with a sample of the students and staff members from each university.

Similar data analysis techniques were used in relation to study II for examining differences by study years. Also following the methodology of the previous study on Brazilian students, second and third year Chinese students were grouped as middle year students [so that all students were in one of the three following categories: first year, middle year(s) or final year(s)]. Differences across gender were examined with the Chi-Square test. In order to detect possible relationships between performance, satisfaction and future study and work plans, the Spearman´s correlation coefficients were calculated. Principle Component Analysis (PCA) with Varimax rotation was used to explore patterns of responses and latent dimensions in the value given by students to generic competencies and experiences, followed by an examination of the differences of the resulting components. PCA is used to reduce the dimensionality of a data set that has a great number of interrelated variables, while retaining as much as possible of the variation present in the data set (Jolliffe 2002). Varimax rotation was used to create orthogonal dimensions aiming at clarifying the PCA results. Mean values given by the students to the competency and experience items were used for establishing the rankings of importance within universities. In the examination of the data, as in the study of Harzing (2006), the percentage of 4 and 5 answers was greater among Chinese and Brazilians as compared to Finns. To minimize this effect, and as commonly done in cross-cultural studies, rankings rather than mean values were used for comparing results across countries, since mean values are more affected by the different response styles that can exist between countries.

5. SYNTHESIS OF RESULTS

The results of this research are summarised according to four sections broadly corresponding to the four papers. The exception to this is section 2, which includes, in addition to the main results of paper II, those findings from paper IV that have the same thematic focus (i.e. changing perceptions of students across years).

5.1 Motivation of international forestry students (paper I)

Motives

One of the main outcomes of the Paper I was the finding of highly motivated students at the initial stage of an international M.Sc. programme in forestry. Such motivation is explained through the combination of their high expectancy for success, and the high value they give to the programme in which they studied. Six main motives were stated by students: (1) a desire to study abroad and get exposed to a different thinking and culture, (2) a desire to join an international programme in relation to its student body, (3) a desire to learn European and/or international forestry, (4) a desire to enrol in a joint programme offered by several universities from different countries, providing upon completion, a double-degree, (5) the belief that the degree would greatly improve their career opportunities, and, for the non-European students, (6) the offering of excellent scholarships.

There were, however, differences in the reasons why students view the programme as of high value. Mainly intrinsic motives such as obtaining knowledge and experiences of European and international forestry, and in a field of specialisation, as well as using and learning state-of-the-art technologies and techniques, were mentioned. Among the achievement motives, many considered the programme as a step for getting into a desired job in the academic sphere or at international organisations. For students from developing countries, the possibility of obtaining a M.Sc. degree from a prestigious university from a developed country was perceived as placing them in a competitive advantage as compared to their peers back in their home country.

Areas of interest

An aspect that came up during this study was that relatively high proportion of the M.Sc. students (over 50%) had in fact ended up entering the forestry related field in their B.Sc. degree as a consequence of not being admitted to some other field of studies (such as medicine). This finding motivated a closer look to the situation in the subsequent studies, including the examination of university entrance systems in the different cases, which are discussed in this thesis. Within forestry, students' most common areas of interest were forest management, silviculture, climate change and carbon sequestration, and forest economics. Thus, the very recent subjects of climate change and carbon sequestration emerged among what we can considered traditional areas of forestry. Also the areas of ecology, Geographical Information Systems (especially remote sensing), wildlife, bioenergy, forest growth, multiple-use forestry, and forest policy were commonly mentioned by students among areas of interest.

Preferences

All students expressed the view that the home country was the best place for undertaking B.Sc. level of education, so as to learn the management of the forest resources in the context of their home country. However this was different at the M.Sc. level, with their preferred destinations for studying a M.Sc. in forestry abroad being Europe, North America, and Japan. Not surprisingly given their actual enrolment, all students pointed out advantages of doing a graduate programme abroad. In addition other reasons were getting a degree that is better valued than the national one, and issues of personal development. A commonly reported disadvantage of studying abroad was the uncertainty concerning the

value of the international degree for domestic employers, especially worrying for the European students.

Students heard of the M.Sc. programme primarily from students already attending international graduate programmes in Europe, with fewer receiving the information from staff of their home universities or through internet search. Most students however applied also to some other graduate programmes in the same year, sending up to six other applications, and most commonly targeting the programmes that offered scholarships: Erasmus Mundus (i.e., applications to the other two Erasmus Mundus graduate programmes in forestry or to related environmental or GIS programmes), followed by the Dutch fellowship programmes Nuffic and Huygens. In the case of these students, the Netherlands was the country that received more applications for graduate programmes, followed by Japan, UK and US. However when asked about their preferred type of programme with regard to mobility, the Erasmus Mundus consortium-type programmes that include study periods in three or more universities was the preferred one.

Goals

Another unambiguous result was the overwhelming desire of the students, upon completion of the M.Sc. graduation, to continue to Ph.D. studies outside their country of origin. In this sense, many were the students who wish to do this at a different continent or country where they attend their M.Sc. Other than Ph.D. studies, most students did not know of their immediate plans for after graduation. An exception to this were those few students who were on a study leave given by their employers (universities, ministries and a non-governmental organisation), although their leave could be also extended for carrying out a Ph.D. degree. Nonetheless, mid and long terms aspirations were generally to return to work at their home countries, with most of them explicitly mentioning their desire to work for the improvement of the situation at their home country.

5.2 Differing views of B.Sc. forestry students across study years (paper II and IV)

Paper II focussed, through a cross-sectional comparison, on the differences in students' perceptions across the study years of a 5-year Brazilian B.Sc. programme. Since the same theme was also among those investigated later in Paper IV in the comparative study of the Chinese, Finnish and Brazilian case studies, a combined synthesis of the main results with regard to the differing perceptions across study years is presented here.

Thus, Paper IV found significant differences across study years in the value given to 7 of the 39 competencies and experience items, i.e. 18% of the listed items. Consequently, in a majority of the items (82%) no clear pattern of difference in the perception of the value across study years was seen. When examining these 7 differing items, however, a relatively similar behaviour across the three universities was detected. Thus, first year students gave a higher value in relation to their senior students to two subject-specific competencies – environmental protection and knowledge of a variety of practices across countries – and one experience item –achieving their best. On the contrary, students in later years of their programme valued more, in relation to first year students, the items: applied statistics, oral communication, writing skills, and having a good social life. With respect to future area of work, the area of consultancy was more commonly preferred by Brazilian and Finnish students of later study years (in the case of the Chinese students, the preference for

consultancy work was very low for all study years). Finally, the remaining differences were case-specific: thus, the proportion of Finnish students who intended to continue immediately to M.Sc. studies significantly decreased across study years, while the proportion of Brazilian students that indicated their preference for M.Sc. studies at the same university also decreased significantly across study years.

Additionally, in paper II an in-depth analysis of the Brazilian students' forestry-related concerns was also carried out with regard to possible changes across study years. These main forestry-related concerns both at national and global levels were grouped in eight categories: conservation, sustainable management, production, forest legislation/policy, climate change/carbon sequestration, environmental problems/impact, economic crisis, and other concerns. At national level, the frequency of answers related to conservation clearly decreased across study years, while there was an increase in answers related to production and forest legislation/policy. Smaller increases across study years in sustainable management-related answers and the category of other concerns were also observed. At a global level, there was a greater variability of responses, reflected in three categories of concerns not present at the national level: climate change/carbon sequestration, environmental problems/impact, and economic crisis. The variety of global concerns was greater and more evenly distributed among students in the last years. Conservation and environmental problems/impact were most frequently mentioned in the first year, while forest legislation/policy, global economic crisis, and other concerns were more frequent among students in the final years that did students in their first and final years. Students of the middle years more frequently mentioned climate change/carbon, production and sustainable management.

5.3 Differing views of B.Sc. forestry students across countries and gender (paper IV)

Generally speaking, there were broad similarities in the way forestry students from the three studied universities perceived the importance of competencies and experiences. All in all, the two most valued subject-specific competencies were environmental protection and related issues (the most valued competency for Brazilians and Chinese, and fourth for Finns), and resource assessment and forest management and planning (second for Brazilians and Finns, and fourth for Chinese). Among generic competencies, the ability to work in groups (first for Chinese, and third for Brazilians and Finns) and the ability to apply knowledge, understanding and problem solving in new environments (second for Brazilians, fourth for Finns and third for Chinese) were perceived as the most important ones across the studied universities.

There was however a greater variation across universities in the perceptions of importance of generic competencies, as compared to subject-specific competencies and experiences. The most important generic competency for Brazilians was foreign languages (sixth for Chinese and tenth for Finns), while for Finns the most important generic competency was the ability to communicate with both field specialists and non-specialists (fifth for Brazilians and eleventh for Chinese). Critical thinking was ranked in fourth position by Brazilians and second by Finns, but in last position by the Chinese students, who on the other hand rated analysis and synthesis as second most important. Through the performance of Principal Component Analysis across the generic competency items, it was found that Chinese students may be giving a higher importance to autonomy skills, with Brazilians prioritizing instrumental skills, and Finns communicative skills.

As with subject-specific competencies, there were common perceptions across countries in the importance of the various experiences that students have during the studies. The three most important experiences were field studies (second for Brazilians and Finns, and first for Chinese), practical experience in work settings (third for Brazilians, first for Finns, and second for Chinese), and achieving their best (third for Brazilians, first for Finns, and second for Chinese). Among the remaining experience items, an important difference was that establishing contacts for employment or further studies was ranked fourth for Brazilians and Finns, but thirteenth (last) by Chinese. Other examples of differing perceptions were the greater importance given by Chinese to doing own research and to developing as a person, and the lower importance given by Brazilians to reflecting and relating new knowledge to previous knowledge. Principal Component Analysis indicated that students from all three universities gave a higher importance to practical experiences over feedback and personal experiences. Feedback experiences were ranked by Brazilians and Finns in second place, while the Chinese rated personal experiences over feedback experiences. Some of these main findings are presented in table 2 (a complete table (3) is provided in Paper IV).

The study also found that the preferred area of work for students from all three case studies was the management of public natural resources. This professional orientation was especially preferred by Chinese students (45% of them choosing it as the first option),

Table 2. Similarities and differences across the case study universities with regard to the average value given by students to the importance of competencies and experiences, as well as the ranking of factors from PCA.

Over-all rank	Subject-specific competencies	UFPR Brazil (n=268)		UEF Finland (n=64)		NWAFU China (n=252)	
		Mean value	Rank	Mean value	Rank	Mean value	Rank
1	Env. protection & related issues such as climate change & carbon seq.	4,36	1	3,61	4	4,21	1
2	Resource assessment and forest management & planning	4,28	2	4,08	2	3,91	4
3	Silviculture & growth	4,09	4	3,98	3	3,90	5
4	Knowledge on an area/subject of specialization within forestry	4,04	5	4,14	1	3,66	9
5	Knowledge of one/more additional disciplines in periphery of forestry	3,90	9	3,41	6	4,05	2
	Generic competencies						
1	Ability to work in groups	4,28	3	4,05	3	4,51	1
2	Ability to apply knowledge & probl. solving in new environments	4,35	2	3,97	4	4,32	3
3	Foreign languages	4,43	1	3,56	10	4,00	6
3	Ability to communicate with field specialists & non-specialists	4,20	5	4,25	1	3,81	11
5	Critical thinking	4,27	4	4,13	2	3,44	13
-	Autonomy skills	-	3	-	3	-	1
-	Instrumental skills	-	1	-	2	-	3
-	Communicative skills	-	2	-	1	-	2
	Experiences						
1	Field studies	4,51	2	4,36	2	4,62	1
2	Practical experience in work settings	4,36	3	4,47	1	4,52	2
3	Achieving the best you are capable of	4,67	1	4,19	3	4,38	4
4	Applying basic (forestry) knowledge and skills	4,09	7	4,11	5	4,18	5
5	Developing as a person	4,25	5	3,31	10	4,44	3
-	Feedback experiences	-	2	-	2	-	3
-	Practical experiences	-	1	-	1	-	1
-	Personal experiences	-	3	-	3	-	2

followed by Brazilians (38%) and Finns (31%). Forest industry was the second most preferred area for Brazilians and Finns, and third preference among Chinese, for whom research was the second preference. Consultancy was preferred by 14% of Brazilian and Finnish students but only 4% of Chinese. In all cases, a majority of students (90% of Brazilians, 83% of Chinese and 74% of Finns) were positive about doing a M.Sc. degree. However, unlike in the Chinese and Finnish university, most Brazilians were considering this as an option for a later stage of their careers (rather than continuing straight from B.Sc., as most Finns and Chinese planned). Among Finns, a weak to medium positive correlation between desire to pursue a M.Sc. and satisfaction with the studies was detected (Spearman´s rho = 0.264, p = 0.037, n = 64), while among Chinese a similar correlation was found (Spearman´s rho = 0.292, p = 0.000, n = 250) between desire to pursue a M.Sc. and their grades at university. With regard to the preferred place to study the M.Sc., most Finns (96%) wished to do so at their current university, while most Chinese (58%) wished to do so at a different Chinese university. Brazilians were the most willing to study abroad (34%), as compared to 24% of the Chinese and just 2% of the Finns. Finnish students were the most satisfied with regards to their studies (average value of 3.81 over 5), followed by Brazilians (3.68) and Chinese (3.09).

While the investigation of gender differences was not a main aim of this study, some interesting results were found and are briefly described. One of them is that female students from Brazil and China (not significantly in the Chinese case) gave a higher importance to the competency of environmental protection and related issues than their male counterparts. With regard to work preferences, a higher proportion of female students in all three universities opted for the area of management of public natural resources (however, this was statistically significant only in the case of the Brazilian university). On the other hand, more male students in all three universities preferred the area of forest industry (though this was only statistically significant for Finland and China). Finally, and according to their self-reported grades, Chinese female students obtained significantly higher grades than their male colleagues.

5.4 Employers and universities´ assessment of market-relevant competencies (paper III)

Paper III examined the perceptions of European employers and universities with regard to the state and needs of the job market and to the competencies provided by M.Sc. level education. Generally, the job market for M.Sc. forestry graduates in Europe was perceived to be undergoing difficulties: the average numerical evaluation of the situation of job market in a scale from 1 to 5 was 2.6 according to employers (i.e. in between poor and acceptable) and 3.4 according to universities (i.e. in between acceptable and very good). For both employers and universities, internships were considered an effective manner to enter the job market: thus, employers declared that they were hiring, from sometimes to frequently, students who had been at the organisation during an internship, though according to universities, this was only occurring from rarely to sometimes.

In general, employers and universities provided similar assessments concerning the importance of competencies and the gap between their achievement in higher education and

the needs of the job market. The competencies where both employers and universities saw the greatest need for emphasis were environmental services, carbon sequestration, and the ability to communicate with specialists and non-specialists. Thus, within three categories of relative importance (higher, intermediate and lower) and gap (larger, intermediate and smaller), universities' evaluations placed environmental services and carbon sequestration in the category of competencies with both higher importance and larger gap (Table 3). In fact, for universities, environmental services were rated as the most important of the subject-specific competencies (mean value of 4.04), whereas the largest gap was found in carbon sequestration (mean value of 1.22).

For employers, the competencies included in the category of having both greater importance and larger gaps were, in addition to the two indicated by universities (environmental services and carbon sequestration), forest bioenergy, products trade and marketing, economics, and governance (tables corresponding to these results as well as to results on generic competencies are provided in paper III). When comparing responses between universities and employers, significant differences in the mean values were found in four of the subject-specific competencies. Employers perceived both bioenergy and products trade and marketing as having a significantly greater importance and a larger gap than universities. Also a significantly larger gap was seen by employers in environmental services and forest economics in relation to universities.

For universities, the competencies included in the category of having both greater importance and a larger gap were the ability to plan, coordinate and organise, and the ability to communicate with specialists and non-specialists. In the case of employers, the ability to communicate with specialists and non-specialists was the only one in this category with both higher importance and gap in relation to other competencies. Significant differences between the perceptions of universities and employers were found for three of

Table 3. Universities' evaluation of subject-specific competencies categorised according to the mean values for importance (I; scale from 1 to 5) and gap (G=I-A) (A: achievement; scale 1 to 5, not shown).

	Smaller gap G ≥ 0.5	Intermediate gap 1 ≥ G > 0.5	Larger gap G > 1
Higher importance I >3.75	Forest ecology Silviculture	Forest information sys. Forest bioenergy Biodiversity Forest governance	Env. services Carbon sequestration
Intermediate importance 3.75≥I ≥3.25	Forest economics Forest planning Production & growth Mensuration & inventory Forest health	Non-wood products Trade & marketing	
Lower importance I < 3.25	Wildlife Operations & Technology Genetics & breeding Forest Soils Biology of trees	Forest ethics & values	

the generic competencies. Universities gave higher importance ratings than employers to the capacity to learn and to written communication skills. On the other hand, employers saw a significantly larger gap than universities in problem-solving ability.

Respondents (universities and employers) were able to add, in a free form, competencies not listed in the questionnaire that they felt were important for the forestry job market. Employers mentioned innovations in wood uses and in forest industries, landscape issues, modelling in climate change scenarios, sustainable forest management criteria, and corporate management. For universities, the mentioned ones were social aspects of forestry (including conflict management), water-forestry issues, and information management.

6. DISCUSSION AND CONCLUSIONS

This section of the study presents, firstly, the main findings and implications according to the issues examined in the papers: (1) students' motivation, (2) students' changing perceptions across time, (3) differences in students' perceptions across countries, and (4) forestry competencies and the job market. In each section, some concrete recommendations are provided. Later, the limitations of this study are examined. Finally, general recommendations for future action and research are given.

6.1 Summary of the findings and their implications

Students' motivation: choice of forestry as field of study

Working with nature and environment is, as discussed in papers I, II and IV, what primarily attracts students to enrol in forestry. This is in line with the results of a survey carried out by IFSA (2010), which found that dealing with environmental issues was the main reason stated by 75% of the responding forestry students. While this is not a surprising finding, this study shows a somewhat more complex reality in the form of a great variability of motives and circumstances among those students already inside the field. In the selected case studies, and in addition to vocational choices, there were many who entered the profession only after failing to qualify for other fields (e.g. medicine, agriculture). Depending on the enrolment procedure of the country or university, cases were seen where students were assigned to forestry studies despite having no interest in the study area: such was the case of some Asian and African students who, after successfully entering their preferred university (an agricultural university), were less successful in the assignation of disciplines. Judging from the discussions with the students as well as in consideration of the university entrance systems in the three studied cases, it can be considered that Finnish students were generally motivated to study forestry (at least to the extent of having taken the entrance examination in forestry), while about one in five of the Brazilians students did not choose forestry as their first option. Although the question was not systematically asked of the Chinese students, the proportion of Chinese that wished to be studying something else may be even higher than the 20% of the Brazilian case.

With these considerations in mind, it seems crucial not only to enhance the attractiveness of forestry programmes but also to better understand students' motivations, as well as motivate and engage them in the studies from beginning to end. The enrolment of

initially less motivated students could be seen as a challenge and opportunity rather than a problem, as a pro-active approach towards those who were unsure about the value of the degree (identifying, explaining and advising on the various professional opportunities in the field) may change their minds, improve their motivation and reduce dropouts. Faculties have responded to the declining enrolment numbers in different ways, such as lowering entrance standards, and changing the names of the departments or the degree programmes in the belief that the term "forestry" has adverse connotations (Innes 2010).

Based on the students' views reported in this study, and with respect to contents, the following actions are proposed to enhance the attractiveness of the forestry degree programmes:

1. to increase emphasis on field studies, including its visibility in the curriculum;
2. to emphasise current issues such as climate change and carbon sequestration, environmental protection, or bioenergy;
3. to emphasise international aspects of forestry;
4. to closely assess and follow-up students' motivation and interests.

Students' motivation: preferred areas of work

The option of working in the management of public natural resources was the preferred area of work among students, compared to areas such as forest industries, research, education, consultancy or environmental advocacy. The fact that the area of environmental advocacy was not highly supported among forestry students may indicate that not many of those interested in the promotion of conservation may be entering the profession (perhaps opting, instead, for studies such as biological or environmental sciences). While these were common trends observed across countries, there seemed to be little awareness of the wide variety of professional opportunities for foresters in all studied cases, an issue that needs to be addressed by the universities. The existence of regular graduate analysis and functioning alumni networks should help to reveal the true potential with regard to employability of forestry graduates. This also encompasses occupations not directly related to forestry, which can constitute a significant share of the jobs for graduates in some countries. For example, according to Lewark and Steinert (2010), as many as 20% of the Freiburg graduates work in fields far away from forestry.

Based on this evidence, and with respect to the attractiveness of the forestry profession, the following actions should be encouraged:

5. to actively promote forestry as a field of study, among the general public and particularly high school students, emphasising the conservation and sustainable management aspects, as well as the role of forests in currently important global issues such as the mitigation of climate change;
6. to carry out sound and systematic graduate analysis as well as develop alumni networks which will enhance the information of the variety of possible jobs for graduates.

Students' motivation: views regarding B.Sc.-M.Sc.-Ph.D. studies and mobility

For a majority of the surveyed students, the home country was the preferred choice of place for studying the first forestry degree. A reason why this may be much clearer for forestry students as opposed to students from other disciplines is the applied character of the field,

with very different local conditions (climate, species, etc) across regions. Most surveyed students were hoping to continue to M.Sc. studies upon graduation from the B.Sc. programme, which indicates a high potential demand for M.Sc. forestry studies. However, unlike a majority of Finnish and Chinese students who wished to continue directly from B.Sc. to M.Sc., most Brazilians were considering to take M.Sc. degrees only after some time at work. The relatively good job market conditions for forestry Brazilian graduates and the great length of their studies (5 years) are seen as possible factors affecting this preference. Among Finns, a possible reason for the willingness to continue to M.Sc. studies may be the uncertainty of the European job market for graduates of the newly created 3-year B.Sc. programmes, a reason that has been pointed out by Crosier at al. (2007). Thus, many forestry European universities may be expecting that most students would continue to the M.Sc. so as to complete a similar education than in the previous undivided 5-year M.Sc. degrees (Major topics of … 2010). The certain correlations seen between doing M.Sc. and satisfaction with the B.Sc. among the Finns, and between doing M.Sc. and having good grades among the Chinese, suggests the existence of two different study atmospheres; one in China involving a very tough competition among students for good grades (that will allow them to continue studying), and another one in Finland more oriented to the student's own pace of development and with the financial support provided by the government stipend.

While the general preference among the surveyed B.Sc. students was to study the M.Sc. also at the home country, there was a majority of Chinese students wishing to do so at a different university within the country (while more Finns and Brazilian preferred their current university). In this sense, the most preferred institutions for the Chinese students were, in this order, Beijing Forestry University, Chinese Academy of Sciences, Chinese Academy of Agriculture, North-East Forestry University, and Chinese Academy of Forestry. In addition to reasons such as institutional prestige, and judging from the arguments given by the students, the attractiveness of living in the capital city Beijing seemed to play an important role.

There were important differences with regard to the proportion of students that preferred to go abroad: 2% of the Finns, 24% of the Chinese, and 34% of the Brazilians. These results are in line with UNESCO data (2009) featuring Finland is a net receiver of international students, and Brazil and China as net senders. While economic issues, language and other considerations are limiting students' intentions with regard to study abroad (according to UNESCO, only around 1-2% of tertiary students in each country go abroad to study), it can be expected that the global number of forestry students going abroad will continuing to grow in the coming years.

Reasons given by the students for going to study a M.Sc. abroad are summarised in paper I, including: to get exposure to a different culture and way of thinking, joining an international group of students; to learn international aspects of forestry; and the belief that the degree would greatly improve the career opportunities. For those doing a M.Sc. abroad, the option of a Ph.D. was seen as a natural continuation. In particular, students coming from developing countries wished to continue to Ph.D. studies also abroad, but had the ultimate intention of returning to their home countries for their working careers. The prestige that a foreign degree earned in developed countries has in many developing countries is seen as a major reason for students to go abroad. This is also the case in other disciplines. For the case of China, Rastall (2009:4) indicates that "there is a welcome for successful well-qualified graduates returning from the West". While the risk of brain-drain has often been discussed in association to international mobility (e.g. Marginson 2006), this fear does not

seem justified in forestry as most foreign students were aiming at returning to their home countries.

Among previous studies that have looked at the factors affecting student choice of international destination, Verbik and Lasanowski (2007) identified eight factors: (1) institutional and programme reputation, (2) social and cultural opportunities of institution, country and region, (3) cost, (4) financial assistance and employment opportunities during and following programme completion, (5) streamlined immigration and visa requirements and procedures, (6) comprehensive and in-depth opportunities to master English, (7) historical linkages between host and home country, and (8) research facilities and resources. For Marginson (2006:3), there is evidence that most prospective students consider institutional reputation as more important than teaching quality, since "some study places offer better social status and lifetime opportunities than others".

With regard to factors influencing country choice for studying forestry, the forest and forestry features (e.g. temperate/tropical, productive/conservation, etc.), together with the visibility, reputation and historical and institutional ties, appear as the key ones. US, Canada, Australia, Japan and Europe (with the most internationally active universities located in Denmark, Finland, France, Germany, the Netherlands, Sweden and the UK) seem to be the greatest receivers of foreign forestry students. In the concrete case of the Brazilian students, the most desired foreign destinations were, in order, Germany (with important historical ties at the level of university cooperation continuing until today), Canada, US, Finland, France, Japan, Australia and South Africa. Chinese students mentioned Europe in the first place (without further specification), followed by Germany, Finland and Canada (at a similar level, and possibly influenced by the direction of the current cooperation of the university), with fewer mentioning US and Japan.

However recent developments such as the introduction of high tuition fees in many European countries where tuition used to be free may have an impact on recruitment, limiting the choice for most students to those programmes that provide scholarships (through national agencies or Erasmus Mundus) or countries with more affordable fees (e.g. Germany, France). Yet, given the constantly increasing international mobility (e.g. OECD 2008) with various scholarship schemes available from both sending and receiving sides, the opportunities for providing education to international students will continue to increase for forestry faculties that are up to the challenge of an increasingly demanding and competitive panorama. Thus, domestic students in these receiving universities will continue to benefit from the presence of international student groups, therefore having opportunities such as the development of competencies for working in multicultural settings while remaining at their own campus.

With respect to the enhancement of career opportunities in forestry, the following is proposed:

7. to conduct studies to better understand the wishes of graduates with regard to further studies and employment;
8. to inform prospective and enrolled students, as well as graduates, of the opportunities for further study and work;
9. to closely cooperate with employers, including those in the curriculum reform and keeping them informed on the type of qualifications and competencies that the graduates acquire;

10. to examine the potential (student interest, employers' demand, economic feasibility) for new international programmes especially at the M.Sc. and Ph.D. levels;

11. to provide career guidance, as well as information and assistance on financial, visa and other matters, paying special attention to the needs of foreign students;

12. to consider, in the decisions of establishing/quantifying tuition fees, the non-monetary benefits of the presence of international students, especially for local students and staff.

Students' changing perceptions over time

While not claiming to have succeeded in unveiling the complex nature of the changes in students' perceptions over the years, the cross-sectional analysis (which examined at one point of time the views from students of different study years) detected certain trends. There were an increasing number of students who preferred working in consultancy among those from later study years, which seems a natural consequence of the students' own development and realisation of their expertise. In the case of the Brazilian university, the existence within the university of a junior consultancy enterprise may have influenced students' perceptions. The idea of having such enterprise can be seen as a positive feature for developing one of the eight key competencies that the European Communities (2007) have stated for life-long learning: the sense of initiative and entrepreneurship. However, with regard to the other work orientations, other changes across study years were not conclusive: detailed and longitudinal studies should be conducted to further clarify this matter.

However, results also suggest that the absence of areas and subjects in the curriculum may lead to a loss of interest and the perception that the area is not as important as previously thought. This was seen in the areas of environmental protection and related issues such as climate change and carbon sequestration (in the Brazilian case study) and in those aspects of international forestry (in the Brazilian and Chinese case studies). Greater attention needs to be paid to this, as it could be linked to dissatisfaction and falling interest in continuing with further studies at the same institution. Nonetheless, the inclusion of attractive elements for students should not, as is often the case, be mostly located in the last year of the studies, as dropout rates will be higher if students are not motivated to continue. Thus, subjects such as introduction to forestry or current environmental issues in the first year should be beneficial for the attractiveness of the studies.

The finding that across the studied universities, students from later years gave higher importance to competencies and experiences such as statistics, oral and writing skills, and appreciation of a good social life, was consistent with that from Jacobs and Newstead (2000) among psychology students. With regards to the statistics, oral and writing skills, the results support a progressive emphasis of these skills along the years of the study programme. Results also show that, across the surveyed universities, the value that students gave to achieving their best decreased across study years. While a conclusive explanation cannot be provided, a similar finding was justified in previous studies, such as that from Zeegers (2001) with Australian chemistry students, by factors such as heavy workload, time commitments and assessment procedures, which pushed students to less demanding study strategies in order to keep up with the course. In this sense, innovative instructional methods are also needed, as students generally expressed their dissatisfaction with the teaching methods.

According to Hu and Kuh (2002), the most promising approach to encouraging higher levels of student engagement on the part of more students is to change the perceptions that students have of certain aspects of the institutional environment. This could be achieved with improved student services and climate and the provision of in-campus activities, which only were significant in the Chinese case study.

On the basis of the students' changing perceptions across study years, the following suggestions for enhancing forestry education at universities made:

13. to conduct studies (including longitudinally-designed ones) to better understand the changes in student perceptions, and detect and address problems such as the lack of motivation or engagement;
14. to examine the students' perceptions of institutional environment, and improve the provision of services and activities;
15. to add new topical areas within a flexible curriculum, allowing for student exploration and development also outside the core forestry subjects;
16. to make available across the study programme subjects that are attractive for students;
17. to integrate teaching of skills and competencies throughout the degree programme, with progressive emphasis on issues such as communication skills, problem solving, and statistical analyses;
18. to promote innovativeness and sense of entrepreneurship among students (e.g. with university-based junior consultancy enterprises).

Differences in students' perceptions across countries

Broadly speaking, similar general views of students across countries with respect to higher forestry education were seen, with a rather common profile of student highly interested in environmental aspects and in a field-oriented education. The similarities were particularly striking with regard to the importance given to subject-specific competencies (silviculture, forest planning, and environmental protection), some generic competencies (problem solving, ability to work in groups), experiences, as well as preferred areas of work. The mentioned generic competencies have also been highlighted as important in previous studies with students of other disciplines (e.g. Gonzalez and Wageenar 2008).

However, there were also significant differences across countries. Thus, with regard to forestry concerns across countries, Chinese students mainly worried about erosion and desertification, Brazilians about conservation, and Finns about the crisis facing the forest industries. Higher importance was given by Finns to gaining knowledge on one area of specialisation, by Chinese to knowledge of one or more subjects in the periphery of forestry, and by Brazilians to environmental protection related issues and forest conflicts and ethics. One suggested explanation to the fact that Brazilians gave a lower relative importance to forest information systems (e.g. Geographical Information Systems) may be its much smaller presence in the B.Sc. curriculum at UFPR (which is the oldest curriculum of the three) as compared to NWAFU and UEF, illustrating also in this case the possible influence of the curriculum on the students' perceptions of importance.

Differences in generic competencies and experiences may be explained by a combination of cultural, institutional and curricular factors. In light of the results of this study, it is hypothesised that students from the surveyed universities valued more those skills they lacked: communicative skills in the case of Finns, and autonomy skills in the

case of Chinese, with Brazilians giving preference to instrumental skills. In addition, and unlike Brazilians and Finns, Chinese students ranked personal experiences over feedback experiences. Cultural measurements such as Hofstede's individualism or power-distance index (2010) seem to be consistent with this interpretation.

Regarding the job market situation, students from the Chinese and Finnish universities expressed great concern for the employment prospects after graduation, a view shared by European employers as presented in paper II. In the Chinese case, the views of the faculty greatly differ on this, with staff members stating that over 75% of graduates were finding employment, with abundant jobs available but with graduates not willing to take them given their location in rural areas. The job situation in Brazil was, as seen by the Brazilian students, much less of a concern. In spite of the differences in the development and structure of forestry and forestry employment across countries, some common traits regarding work preferences were found. Management of public natural resources remained the most preferred area of work for forestry students from the surveyed universities, although with a greater support in China in relation to Brazil and Finland, which may reflect the weight of the state in the respective forestry sector. In Finland and Brazil, this was closely followed by the desire to work in their forest industry sector, which is of great international importance, whereas in China – with a more modest industry sector – the second preference was research. Environmental advocacy was only an attractive choice of work for Finnish forestry students. However, major differences in the nature and development of Environmental Non-Governmental Organisations (ENGOs) in the different countries need to be considered. For Hochstetler and Keck (2007), within the sphere of action of Brazilian ENGOs there is a complex and distinctive socio-environmentalism that addresses simultaneously ecological destruction and social injustice. In China, ENGOs can be considered to be in an emerging state and largely subordinate to the political field (Yang 2005).

Gender issues

Inequalities in forestry, a traditionally male-dominated field, have been often pointed out, with men still dominating the workforce in most countries and earning more than their equally qualified female counterparts, and with women generally absent from policy-making processes (FAO 2006, 2007). Although gender issues were not a primary focus of this study, data from paper IV was also examined for any possible gender-related differences. At the level of student population, the global imbalance reported by FAO (2009) of 33% female student was only found at the Finnish university (with that same share – 33% – of female students), a finding which is in line with the lower presence of female students commonly reported in other Nordic countries such as Sweden (Lidestava and Sjoumllanderb 2007). Such imbalance was not seen in the Chinese and Brazilian case studies (46% and 52%, respectively), where in the last years there has been an increasing proportion of female students enrolling in forestry.

At the level of student perceptions, only small differences were observed across gender, with Finnish and Brazilian female students giving higher value to the area of environmental protection in relation to their male colleagues. More significant may be the differences with regard to work preferences, which were detected locally: a greater interest in working at the industries among males in Finland and China, more Chinese females preferring to work in education, and more Brazilian females preferring to work in management. Such differences may reflect the fact that some stereotyped perception of gender roles in forestry persists and

is already influencing the students' wishes. The perception of forestry as a "male profession" is, according to Kuhns and colleagues (2002), a primary reason why more women are not pursuing a career in forestry. It may be that a similar association is made in some countries within the forestry sector, with an association of forestry industry as more suitable for male graduates. Since such socially constructed gender roles not only prevent women from taking jobs but also discourages others from considering them as an option, greater attention as well as gender mainstreaming in forestry (as proposed by FAO 2007) seems necessary so that such inequalities do not get perpetuated.

Based on this discussion, and with respect to students' differing perceptions of forestry education and profession across countries and gender, the following proposals are made:

19. to conduct studies so as to raise awareness of the differences in students' views, concerns, and expertise, so that better knowledge can be obtained on how to deal with and get benefit from international students;
20. to increase networking between forestry higher education institutions and the sharing of experiences (e.g. sense of entrepreneurship in Brazil, high student satisfaction in Finland, environment and in campus activities in China);
21. to pay attention to gender issues and promote equality, adding gender-related issues to the curriculum.

Forestry competencies and the job market: the need for continuous evaluation and reform

Results from paper III revealed a considerable gap between the competencies that are provided at universities and those required at the job market, as seen by European forestry employers and universities. This finding is in line with previous studies (e.g. Forest Technology Platform 2005, European Commission 2006). A major reason for this gap is the combination of rapidly increasing number of aspects to be covered (including the most recent ones with regard to inventory through laser scanning, carbon sequestration, of energy from forests) with old and rigid curriculum. While the knowledge and experiences that can be transferred is limited by the length of the study programme, the importance of generic competencies such as learning ability seems more important than ever before.

Among the studied universities, two very different situations with regard to curriculum reform were found. On one hand, the curriculum in the Finnish case study had already been reformed twice, by the faculty itself, since 2007. Similarly, most M.Sc. programmes in Europe have been created or reformed within the last decade. On the other hand, the Brazilian university has a curriculum dating from 1991, despite several years of planning and working through a highly complex reform process which involves the university and the Ministry of Education. As indicated by Taylor (2000), it is clear that continuous reforms are needed as changes in societal demands occur. These reforms should not only consist on the substitution or addition of subjects but address the present and future needs of forestry professionals including the development of abilities and attitudes for handling increasingly uncertain and complex scenarios.

The extent to which the job market should influence or determine what is taught at higher education institutions is a complex issue. According to Brennan et al. (1996:12), "higher education plays a role in the employment system by providing job-related knowledge and competencies, and in pre-selecting students for future jobs". Improved competitiveness and social utility are some of the arguments in favour of the alignment of curricula with the needs of the market. On the other hand, academic freedom, university

autonomy and the role of university in developing autonomous citizens and leaders (Giroux 2003) are some of the counter arguments.

The survey of universities and employers found agreement in their views about a number of areas that are adequately covered in existing higher forestry education, among them biology of trees, forest soils and ecology. From the employers' answers, even an excess of emphasis was being given to some of these competencies – especially tree biology/physiology – in relation to its importance in the professional forester market. A common need seen by both universities and employers relates to the existing gap in some generic skills, mainly the ability to communicate with specialists and non-specialists, and the planning/organising ability. Deficiencies in the ability to communicate by forestry graduates have been previously reported (Ball 2003, Forest Technology Platform 2005, Vanclay 2007). Furthermore, some of the results coincided with those of Garcia-Aracil and Van der Velden (2008) from a large-scale European graduate survey across disciplines: a large gap was found in planning/organising ability and in negotiation skills, and almost no gap in broad knowledge of the subject and in the ability to learn. Although employers and universities generally agreed that gaps in certain competencies exist, employers tended to see larger gaps than universities; such was the case regarding problem-solving ability, which should be more emphasised at universities according to employers. The high relevance for employment found in this study for problem solving and teamwork competencies is consistent with the views expressed by European graduates and employers in various disciplines (Gonzalez and Wagenaar 2003) and those from Finnish forestry students (Schuck 2009). From the employers' perspective, a need was also seen to prioritise the areas of forest bioenergy, products trade and marketing, economics, and governance.

The general views among universities and employers indicate that the European professional forester market for graduates is going through a difficult period. In this context, a clear need is seen for stronger networking and partnerships between higher education institutions and employers. Collaborations through internships are suggested as a useful tool, as it seems that employers often hire those who have been at their organisation as interns during university studies. Internships have in fact been recommended in the European context as integrated elements of degree programmes (Employability in the… 2004).

Based on the analysis of the views of European employers and universities, and with respect to competencies and curriculum, the following actions are suggested:

22. to carry out continuous evaluation and reform of the curriculum, consulting and taking into consideration the employers' needs;
23. to emphasise the area of environmental services, and particularly carbon sequestration;
24. to emphasise generic skills, especially those related to life-long learning, as well as the ability to communicate with specialists and non-specialists, and the abilities for planning/organising, problem solving and teamwork;
25. to develop student expertise by integrating internships in the study programmes, as well as integrating students in the research and project work carried out at their higher education institutions.

Forestry degree programmes and further education

Within the present higher education debate, the issue of the provision of a more integral and general versus a more specialised education, as well as the issue of in which of the levels (B.Sc.-M.Sc.-Ph.D.) this specialisation is desirable, have been discussed. A great variability of models currently co-exists in the provision of forestry education globally. Despite their various lengths (3, 4 and 5 years), the three B.Sc. study programmes examined in this study may be regarded as general forestry programmes, covering all important aspects of the discipline and without specialisation in a particular area. With the exception of the Finnish case, where the students are required to take an unrelated minor (consisting of a block of courses), the other two programmes did not leave much room for subjects outside the forestry-related ones, a case that is very common elsewhere. In a context of a general diversification of degree programmes according to specializations, the Melbourne Model approach has recently attracted a lot of attention as it has moved in the opposite direction. Thus, this model has reduced the number of Bachelor degrees offered by integrating all undergraduate studies in just six "new generation" programmes (University of Melbourne 2011). Within these six Bachelor degrees, there is the possibility of choosing among 80 fields of interests. As a result, at Melbourne University forestry is moved to the graduate level (in the form of M.Sc. Forest Ecosystem Science), while suggested tracks for enrolment in such M.Sc. are two of the six new generation B.Sc. programmes, concretely those of Science and of Environments. Regardless of the positive or negative aspects of these different structures, issues of minimum qualifications and admission into M.Sc. programmes across systems will have to be addressed.

Although the issue of continuing and professional education was not thoroughly examined in this study, important differences were seen across the studied universities, with extension work and training of professionals being of much higher importance in the Chinese one (including the presence of one forestry extension subject included in the curriculum). In the Finnish case, only one initiative of continuing education was in place in 2010. Interestingly, this was not involving the training of nationals but of foreign forestry professionals, concretely Indian Forest Officers involved in a 2-week intensive foreign module of their mid-career training, funded by the Government of India (Arevalo and Tahvanainen 2011). Among the most significant barriers for a greater role of the universities in continuing professional or personal development for those already in the work force, structural and cultural inflexibilities have been pointed out (European Council 2010), with stronger university-business partnerships suggested in this respect. Nonetheless, the development of continuing education for those already in the work force can be seen as a great opportunity by universities.

Instructional methods

Great room for improvement exists, judging from students' responses, with regard to teaching methods. Answers revealed that the surveyed forestry students were mostly neither disappointed nor satisfied with the teaching methods, with Finnish students slightly more satisfied than Chinese and Brazilians [average values of 3.1 in Brazil and China, and of 3.6 in Finland (measured in a scale from 1=extremely disappointed, 2=disappointed, 3=neither disappointed nor satisfied, 4= satisfied, to 5=extremely satisfied); data not included in the papers]. However what is more worrying is that in all three universities, average satisfaction decreased along the study years.

While the issue could not be analysed with sufficient depth, the impression obtained from the discussions and observations is that not much innovation with respect to traditional teaching methods was being employed. This may be the case in spite of the research stating the benefits of various teaching and learning methods, and which emphasises the traditional lecturing method as the least efficient. Thus, in the learning pyramid attributed to the National Training Laboratories in Bethel, Maine (undated), some figures of retention for different learning methods have been proposed: 5%-lecture, 10%- reading, 20%-audiovisual, 30%-demonstration, 50%-discussion group, 75%-practice by doing, and 90%-teach others/immediate use of learning. While some authors have questioned these figures (e.g. Sousa 2006, Lalley and Miller 2007), the pyramid is commonly referred to in the literature and often used in workshops for discussing teaching and learning (Magennis and Farrell 2005). Accordingly, the combination of several of these methods in forestry education offers great potential. An example of an experience of problem-based learning in a forestry M.Sc. course has been described in a paper involving the author (Arevalo et al. 2010), with students showing greater satisfaction with the course and its methods (as per the analysis of the feedback) in relation to previous editions of the course. Attention should also be paid to new and increasingly relevant theoretical ideas about learning, such as authentic learning and engagement theory. Drawing on the concepts of situated learning and cognitive apprenticeship, authentic learning focuses on real-world relevant tasks (e.g. Herrington 2006). For the proponents of engagement theory, the three key components of a learning activity are their occurrence in a (collaborative) group context, their project-based nature, and their outside (authentic) focus (Kearsley and Shneiderman 1999).

In addition to an increased use of research-based instructional methods and the consideration of emerging interpretations of learning, the use of ICT also offers great potential in forestry education. According to the US Department of Education (2011), the future model of learning will be powered by technology with the creation of relevant learning experiences that mirror students' highly connected daily lives. However, only few experiences with regard to forestry education have been shared, mostly limited to the use of internet. So far, North American universities seem to dominate web-based forestry education, with a main orientation towards extension and professional education (e.g. Roth and Finley 2007, Allred and Smallidge 2010). A recent review of the use ICT in forestry by Zschocke and Jansky (2010) refers to the work of Vacik et al. (2006) with the use of silviculture software COCCOON in Austria, the use of PUME simulator in Finland (Vanninen et al. 2006), the e-learning experiences described by Längin et al. (2004) in Germany and South Africa, and the work by Olsen and colleagues (2004) in a tropical forestry course in Denmark. Further research as well as the sharing of these experiences should be encouraged.

The following aspects are suggested in this sense for enhancing forestry degree programmes:

26. to increase the flexibility of the study tracks and choice of elective studies;
27. emphasis on transdisciplinarity, including (1) the re-consideration of admission policies so that the best students can be recruited not just in relation to their factual knowledge and passed subjects, but also in consideration of their generic competencies and knowledge of other disciplines outside forestry; and (2) the inclusion of a greater general flexibility as to accommodate talented students from diverse degree structures (e.g. Melbourne Model Bachelors), with the provision of supporting courses when lack in important areas is detected;

28. the use and sharing of experiences regarding innovative instructional methods, emphasising authentic and situated learning (e.g. collaborative problem based learning that focus on real life problems), and including ICT;

29. the exploration and development of continuing education as an additional option to be offered by universities at both national and international levels;

30. the training of educators in issues such as pedagogical methods and ICT, gender issues, and the teaching of international students.

6.2 Limitations of the study

Given on one hand the limitation in time and resources that any doctoral dissertation faces, and on the other the great variety of issues of interest that would need to be studied in the field on international higher forestry education, this study adopted an exploratory character, focussing only in certain aspects in a few case studies. Two main issues can be highlighted as the main limitations of the study: firstly, those connected to the study methods, and secondly, those on the representability and generalizability of the results.

With regard to study methods, the results need to consider the limitations associated to any study dealing with perceptions, as there may have been different interpretations made by respondents and the researcher in the meaning of the responses. Even though the research design combined qualitative and quantitative methods to obtain complementary results, it is also possible that some important issues remain undetected. In this sense, three main aspects that need to be taken into account are: (1) the use of a limited number of shortly defined competencies, (2) the cross-sectional method for examining differences across years, and (3) the language and cultural issues pertaining to cross-national studies. These issues are further discussed in the different articles.

Secondly, the results of this study cannot claim representativeness in the global or even national levels, as they originate only in data from a few case studies. Although the selection of the case studies was partly motivated by issues of geographical distribution, these results cannot either claim to be of general applicability, especially considering the great variety with regard to the quality of forestry education programmes. Nonetheless, it is believed that the study provides a variety of in-depth views that can be relevant to a large number of stakeholders worldwide. Moreover, in the absence of previous studies dealing with higher forestry education from an international perspective, these results can serve as the basis for the much needed further discussion and research in the field.

6.3 Final remarks: towards the 21st century forestry education

The forestry sector can be regarded as one of the few major areas that can become truly sustainable by providing economic growth, rural jobs and the sustainable forest management (e.g. Forest Technology Platform 2005). Increased information on the current state of higher forestry education and its reforms, enrolment trends, and career opportunities for its graduates seems fundamental to ensure the profession continues to attract highly competent people. An increased effort in the follow-up of graduates by universities and the visibility of the numerous possibilities that forestry professionals have in the professional forester market is crucial for the strengthening of the profession. The emergence in recent years of issues related to climate change (carbon sequestration, use of

bioenergy) adds to other global concerns (biodiversity, water availability, deforestation) in which forestry plays a major role. This can be seen as an opportunity for the field's renaissance. Reforms and coordinated actions are needed so as to reverse the declining number of enrolments in forestry throughout the world that started in the 1990s (Temu and Kiwia 2008). The improvement of the image of the forester is needed, so that it is seen as a modern, communicative and versatile nature resource expert and manager.

This study had a main focus on the perceptions of the most important stakeholder in the educational process: the student. As the recipients of the education, their views can certainly help in an evaluation of the education and profession, providing important signs for their development. While it is not suggested that curricula should be shaped only on the basis of the students' views, a greater involvement and consideration of their views in the curriculum reform can only be beneficial. Students' perceptions need to be monitored, as literature shows the great importance of their perceptions on the learning experience, for example influencing student's motivation which in turns influences deep learning approaches (Boddy et al. 2003). Understanding the motivation of the students (those highly motivated to learn, those who adopt an achieving orientation so as pass the courses and get competitive grades, those who do it for other reasons such as parental pressure) will be helpful to design courses and evaluation methods that maximise learning and development.

Higher education institutions need also to pay more attention to what happens outside the classroom, as it is also part of the learning environment. This, referred to by some as "school climate" (Freiberg 1999), includes a greater follow-up of students' physical and psychological wellbeing (including motivation), as well as the provision of social and cultural activities. Only through this can the true engagement of students at behavioural, cognitive and social-emotional levels be achieved. Opportunities for promoting learning on-demand, especially outside the classroom (through for example social media) seem one of the most prominent opportunities ahead.

Among the thirty measures suggested for improving higher forestry education, three key aspects can be emphasised. The first is the consideration of forestry as a transdisciplinary field, where the knowledge and expertise from a multitude of areas needs to be integrated. The second is the focus on the development of students' competencies, with especial attention to generic competencies and attitudes. The third is the use of appropriate learning methods in suitable environments, which may be different for different students, draw on technological innovations and expand outside classroom settings.

Further research on higher forestry education is needed, and in the absence of other professionals carrying it out, it corresponds to the people working in the field of forestry to promote and be part of such research. As stated by Brennan (2008:392), "the purpose of researching higher education is not just to make higher education better – although hopefully it will also do that –but to enhance our understanding of contemporary societies and the futures that are available to them". Decisive action on the enhancement of forestry education must be urgently taken so that future foresters can become relevant, qualified, versatile and prestigious professionals that are able to make an impact towards a greener and more sustainable society.

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