

# Chemistry in Environmental Sciences Related Higher Education (BSc and MSc)

## Programmes in Europe

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## Motivation, aims

- Environmental Chemistry is a rather young field / discipline, born in response to problems / societal needs (pollution) which requires interdisciplinary competence and have transdisciplinary implications (economic, legal, public).
  - Is it existing on mind maps of students, scholars and the public ? - as being more than the sum of the disciplines it is rooted in (physical chem, org chem, geochem...) ?
  - The Bologna Process lead to a diversification of existing programmes of higher education in Europe.
- What is the significance of
- the fields environmental chemistry and ecotoxicology in study programmes in the environmental sciences ?
  - the environmental sciences in general in higher education in Europe ?

## Method → Survey covering

- all Bachelor and Master level courses,
  - in all of Europe, including Turkey and Israel, but without Russia and Ukraine
- via delegates to the DCE / national chemists' networks (15 countries), or direct contact to scholars and scientists (13 countries), or information available through the WWW (15 countries)

## Questionnaire asking for:

- Type & name of degree, host university/school & faculty
- website of programme & email address of coordinator, credit points allocated to the programme
- Credit points allocated to environmental chemistry
- Focus, approach and elements of the programme (text)
- Other related questions (Is there a demand for multidisciplinary education in your country ? Which programmes in Europe would you recommend ?)

- 450 questionnaires were filled out
- 234 public universities, 1 private university and each 2 research institutions
- in 28 countries
- 333 relevant\* programmes were identified: 156 bachelor (out of which 148 BSc), 181 master (out of which 176 MSc), 2 diploma and 6 other

### **Relevance:**

- any significant coverage of chemistry considered relevant
- chemistry, ecotoxicology in the title, apart from programmes centred in the geo-, biological sciences or engineering
- engineering / environmental technology not focussed but to some extent included

### **Caveats, biases**

The information collected may be incomplete as:

- Despite the effort made to achieve completeness, relevant programmes could not be identified (Env Eng Technol degrees: there are probably many more with relevant courses)
- Questionnaires, although relevant, were not returned [despite repeated request to do so, relevant for approaches (a) and (b)].
- , some of this information can be outdated or changed until publication (2014), and more so by today

# Results: Geographic coverage

**Table 1** Number of BSc and MSc programmes with environmental chemistry included per country, in brackets number of programmes with percentage of courses given in English > 50 %<sup>a</sup>

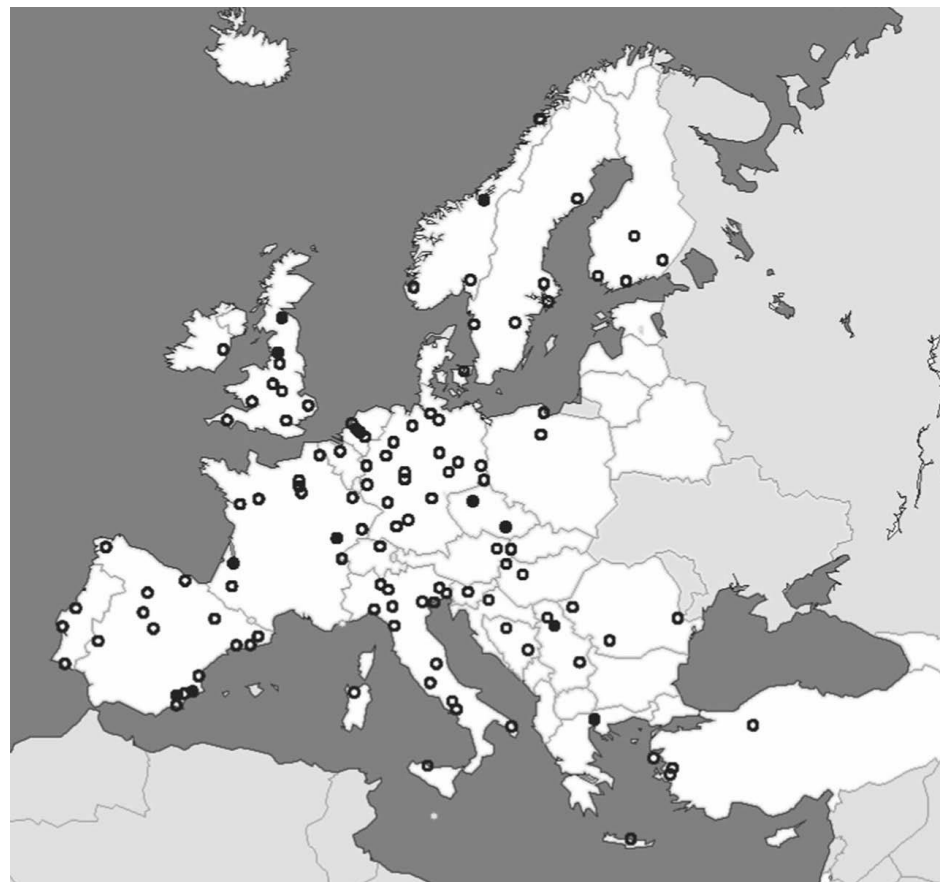
	Bachelor	Master <sup>b</sup>
Total	156 (30)	181 (62)
Austria	0	1 (1)
Belgium	0	1
Bosnia and Herzegovina	2	2
Croatia	1	1
Cyprus	1	0
Czech Republic	2	4
Denmark	1 (1)	2 (2)
Finland	1	6 (3)
France	20 (1)	27 (1)
Germany	20	30 (11)
Greece	3	5 (2)
Hungary	2	3
Ireland	2 (2)	1 (1)
Israel	0	1 (1)
Italy	23	16
Netherlands	3 (1)	8 (8)
Norway	1 (1)	5 (2)
Poland	4 (3)	5 (4)
Portugal	4	3
Romania	7	3
Serbia	4	5
Slovakia	1	3
Slovenia	2	2 (1)
Spain	26	22 (3)
Sweden	5 (1)	7 (6)
Switzerland	2 (1)	2 (1)
Turkey	0	4 (3)
UK	19 (19)	12 (12)

<sup>a</sup> Including programmes where language is switched to English if non-native students are enrolled

<sup>b</sup> Including diploma programmes

## MSc programmes

- with environmental chemistry or ecotoxicology
- with environmental chemistry in the title



30-50 programmes in DE, ES, FR, IT, UK, corresponding to 0.5-0.8 programmes per million inhabitants.

6-11 programmes in SE, RO, PL, SRB, FIN, GR, PT, CZ, NO corresponding to up to 1.3 programmes per million of inhabitants

**Results: Disciplines covered**  
 subjects in programme titles which offer environmental chemistry or ecotoxicology: 497 in 316

for example: ‘Environmental Science and Engineering’ counted as Env Sci and Env Eng, ‘Geoecology’ counted as Geo and Ecol, ‘Chemical Sciences and Technology’ counted as Chem and Chem Technol and ‘Environmental Toxicology and Chemistry’ counted as Ecotox and Env Chem

numbers of programmes (in parentheses)

Subject	Bachelor programmes	Master programmes	Other programmes
Agriculture, Agrobiol, Landscape	3 (3)	21 (6)	– (0)
Air	see Atmosphere		
Arctic	– (0)	– (0)	100±0 (3)
Atmosphere	n.d. (1)	10 (2)	– (0)
Biol	see Ecology		
Biotechnol	56 (2)	28±16 (4)	– (0)
Chem, Analytical Chem	38±28 (9)	49±34 (13)	100 (1)
Chem Eng, Chem Technol, Technol Chem, Chem Processes	22±19 (22)	20±16 (6)	– (0)
Chem Technol	see Chem Eng		
Cities	see Urban		
Climate	see Env Physics		
Earth	see Geo-		
Ecology, Ecosystems, Env Biol, Biol, Life	9±4 (15)	19±16 (34)	– (0)
Ecotox, Env Contamination, Env Toxicol	– (0)	44±17 (9)	100 (1)
Education	see Teacher		
Energy	see Env Physics		
Env	see Env Sci		
Env Assessment	n.d. (1)	43±49 (7)	– (0)
Env Biol	see Ecology		
Env Chem	44±49 (4)	8±28 (9)	– (0)
Env Eng, Env Technol, Technol Chem	14±17 (25)	11±17 (35)	– (0)
Env Heritage	see Nature		
Env Management	28±26 (7)	30±17 (16)	– (0)
Env Modelling	see Env Phys		
Env Physics, Systems Analysis, Climate, Energy	20 (1)	4±26 (7)	– (0)
Env Prot, Quality Management, Remediation, Pollution Control	23±26 (6)	10±17 (15)	– (0)
Env Sci, Env Studies, Env	14±9 (81)	21±29 (65)	50 (1)
Env Tox, Ecotoxicol	3 (1)	– (0)	– (0)
Geo-, Earth	15±14 (10)	35±17 (7)	– (0)
Geography	see Geo-		
Forest	6±1 (3)	– (0)	– (0)
Health	3 (2)	10 (1)	– (0)
Mine	see Water		
Nature, Nature Conservation, Env Heritage	13 (2)	10 (2)	– (0)
Ocean	see Water		
Radioecology	– (0)	50 (1)	– (0)
Remediation	see Env Prot		
Technol Chem	see Chem Eng		
Toxicology, Pharmaceutical Toxicology	11 (1)	16±8 (4)	– (0)
Urban, Industrial, Cities	n.d. (1)	28 (2)	– (0)
Waste	33 (1)	– (0)	– (0)
Water, Aquatic, Marine	9±6 (8)	21±15 (11)	– (0)

➤ 2/3 can be allocated to sciences, <1/3 to applied sciences/technology  
 ➤ “Environment” exists in 75% of programmes, while “Ecology” and “Environmental Engineering” exists in 15-17% of programmes. “Chemistry”, “Sustainability” and “Water” are identified in 6-7% of programmes.  
 ➤ Offered courses are more similar than subjects suggest.

## Results: Disciplines covered - Example

Study plans of the most focused intl. master programmes



### **Aristotle University, Thessaloniki / GR**

Department of Chemistry offers MSc studies on Environmental Chemistry/Environmental Technology:

- Environmental Chemistry and Pollution Control (90 ECTS)
- Chemical and Environmental Technology (90 ECTS)
- Environmental Physics (120 ECTS)
- Ecological Water Quality and Management at a River Basin (90 ECTS)
- Chemical analysis – Quality Control (together with University of Athens / School of Chemistry)

School of Geology offers:

- Meteorology, Climatology and Atmospheric Environment (120 ECTS)
- Applied and Environmental Geology (90 ECTS)

School of Civil Engineering offers:

- Environmental Protection and Sustainable Development (75 ECTS)

School of Civil Architecture offers:

- Protection, Conservation and Restoration of Cultural Monuments (90 ECTS)
- Environmental Architectural Design (120 ECTS)

Department of Forestry and Natural Department

- Sustainable Agriculture, Management on Natural Resources and Foods (120 ECTS)
- Forestry and Natural Environment (90 ECTS)

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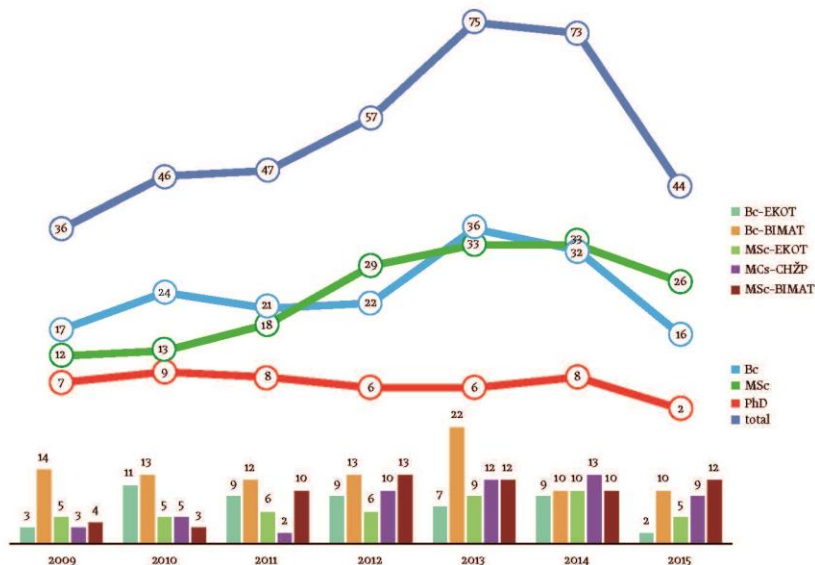


Masaryk University, Brno /CZ

MSc in Chemistry Environmental Chemistry major  
Graduates in 2011-15: 2 - 10 – 12 – 13 – 9 students

BSc in Experimental Biology, Ecotoxicology major  
Graduates in 2011-15: 9 – 9 – 7 – 9 – 2 students

MSc in Experimental Biology, Ecotoxicology major  
Graduates in 2011-15: 6 - 6 – 9 – 10 – 5 students



BIMAT - computational biology  
EKOT - ecotoxicology  
CHZP - environmental chemistry

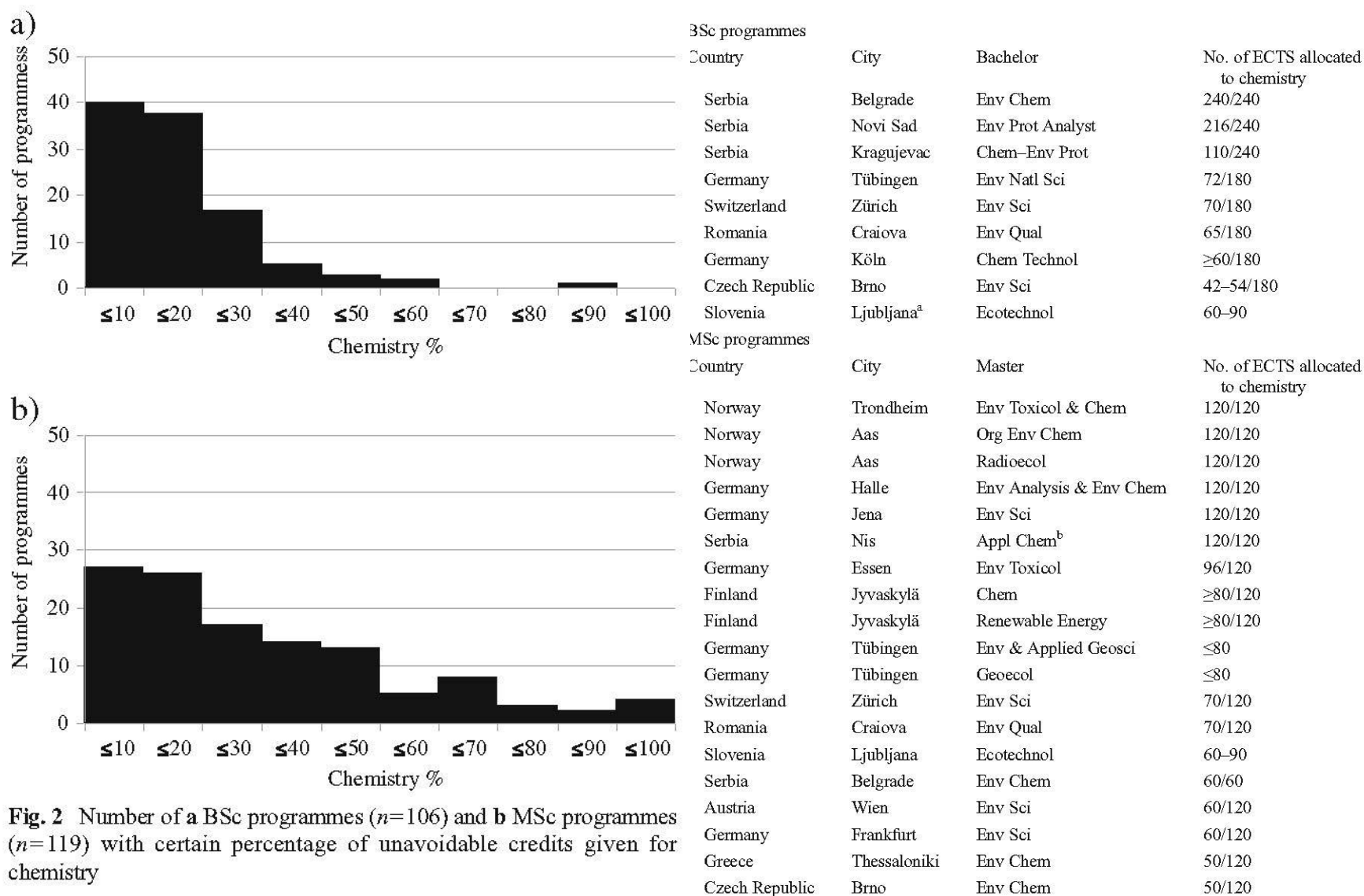


CHARLES UNIVERSITY

Prague /CZ

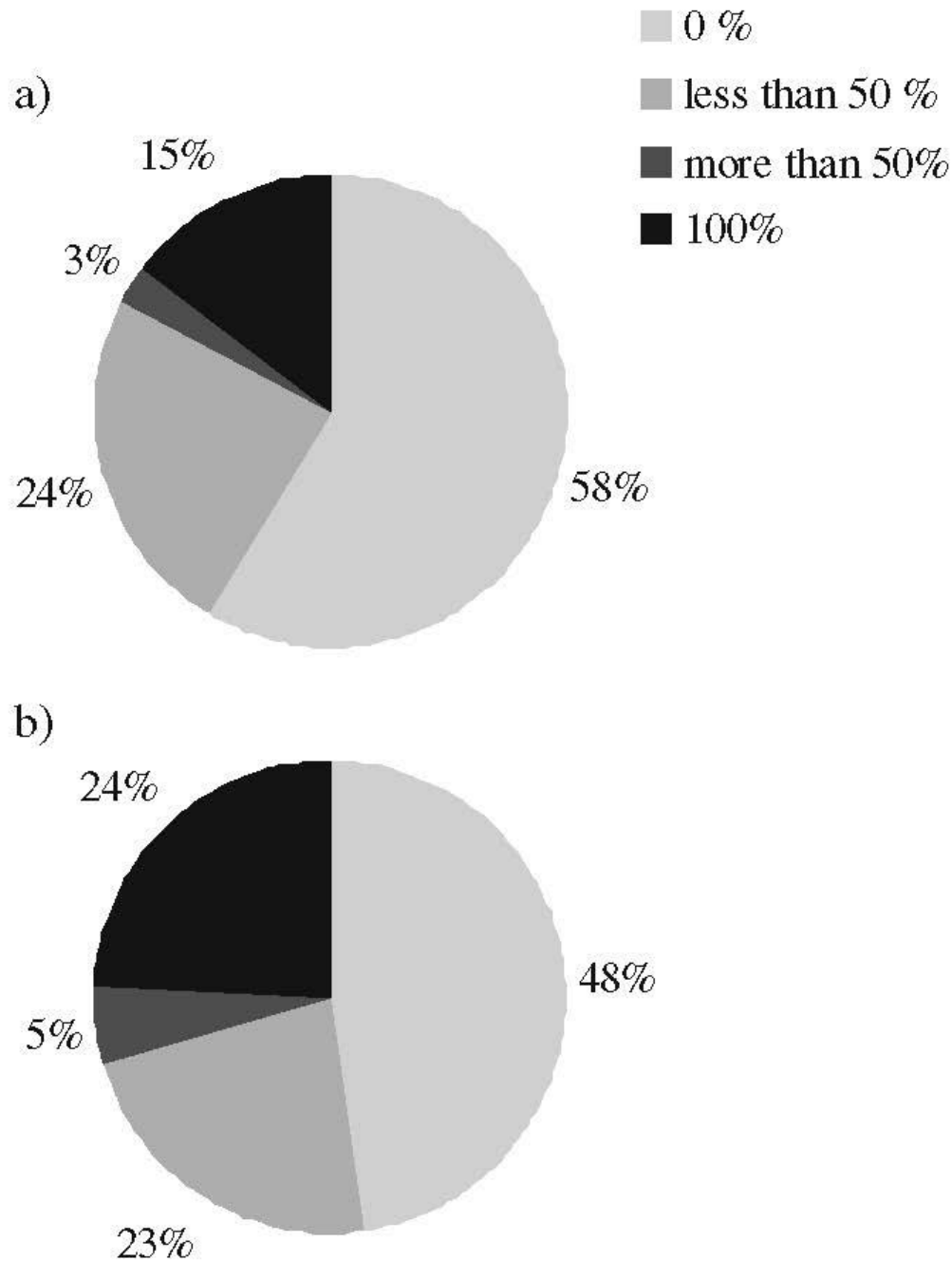
MSc in Chemistry  
Environmental Chemistry  
major (2012-16):  
6 – 8 – 8 - 11 – 9 students

# Results: Representation of chemistry in the curriculae



**Fig. 2** Number of **a** BSc programmes ( $n=106$ ) and **b** MSc programmes ( $n=119$ ) with certain percentage of unavoidable credits given for chemistry





**Fig. 3** Percentage of courses given in English for **a** BSc programmes ( $n=116$ ) and **b** MSc programmes ( $n=132$ )

## Results: Language

- English is still not the rule in master programmes
- Flexibility in TR (2), GR (2): English if at least 1 foreign student present/enrolled
- According to the Bologna goals, a big share of the courses, especially at Master level, is taught in English. It is expected that this share will increase and contribute to mobility.

## Motivation

- Environmental Chemistry (EC) is a rather young field / discipline, born in response to problems / societal needs (pollution) which requires interdisciplinary competence and have transdisciplinary implications (economic, legal, public). Is it existing ?

## Conclusions:

- EC seems to be established as a discipline. It is offered in courses of  $\approx 25\%$  of the universities (total:  $\approx 1000$  universities)
- EC & Ecotox are offered in all except a number of small countries. An additional hidden contribution may exist due to programmes overlooked in the survey.
- The diversity of the programmes subjects reflects their interdisciplinary nature and of the discipline EC itself.
- The share of English should increase
- Significance of multidisciplinary education and demand on the national job markets is very diverse across Europe (and changing)

# Results including weblinks to all programmes

→ *Environ Sci Pollut Res* 21 (2014) 7211-7218

Thank you for your attention!

## Questions ?

:

- Could modern tools/instruments be used to exploit synergies across universities ?  
Exchange materials ? open source courses ? massive open online courses (MOOC; students watch lectures online at home)?

- Wide scope and diversification of MSc programmes vs. postgraduate courses (→ Rolf Duering 11:30, summer schools e.g. at MU Brno since 2005): complementary, demands satisfied ?

- ...

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