SUSTAINABLE URBAN WATER MANAGEMENT IN PRAGUE, CZECH REPUBLIC

Findings from an interdisciplinary academic consultancy training course in Urban Environmental Management

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Abstract

This paper presents the findings of a multi-disciplinary MSc Academic Consultancy project (Urban Environmental Management, Wageningen UR) on urban water management (UWM) in Prague, executed by 30 students in May and June 2010. The aim of the project was to provide the client Arnika (an Environmental NGO) scientific evidence and international best practices in urban water management as an input to the new Spatial Plan in Prague; the opinion of stakeholders (opinion leaders as well as normal citizens) on this issue and specific recommendations for action and communication on urban water management in the near future. The research was done in 5 districts in Prague, drawing upon 5 fields of expertise. The didactic model which was applied to the research is based on an interdisciplinary approach that helped students to combine knowledge from different disciplines, understand cultural differences when designing sustainable solutions for complex environmental problems. The paper concludes that the didactic model proved to contribute to the knowledge and understanding of the client on the UWM issue as well as students´ professional skills development.

Keywords

Urban Water Management, Prague, Czech Republic, Interdisciplinary Approach, Didactic Model, Sustainable Education

1. Introduction

The present paper presents the results of a research which was performed within the European Workshop Environmental Sciences and Management (EUW) course at

Wageningen University and Research Center. The course is intended for first year master students who do their studies in the field of environmental sciences and urban environmental management. The course consists of three parts. In the preparation period students apply their knowledge of environmental sciences and management to make a project plan based on the Terms of Reference received from a real client which in 2010 year was an environmental non-governmental organization (NGO) Arnika from Czech Republic. The second part consists of two weeks field work to Prague mainly dedicated to data collection. At the end of this part the preliminary results were presented to Arnika and other interested stakeholders in an open session. Finally, students analyzed the data, incorporated the feedback from the client and wrote a concise report.

The course pays an essential contribution to the learning outcomes of the Master Program in Urban Environmental Management, as it applies interdisciplinary approach as fundamental to the learning process. The Master Program is designed to equip students with an outlook, concepts and tools to manage complex urban environments in the most feasible and sound manner. This is the reason why the program emphasizes the development of cross-disciplinary and critical thinking, analytical problem-solving and practical decision making skills. This is obtained through a balanced combination of theoretical and practical courses, team work, simulation exercises and individual research projects (Study Handbook, 2009/2010). In this context, EUW as a course within the above mentioned master program, contributes to this balance and plays an important role in fulfilling the students learning outcomes, and provides students with an opportunity to develop skills which help them to bridge the gaps that exist between theory and practice, disciplines, cultures and settings.

Academia refer to an interdisciplinary course as “a course which focuses on a theme, or an issue/problem which is studied from two or more disciplinary perspectives, and in which the faculty members of the course present an in-depth discussion and analysis of these two or more disciplinary perspectives and in which students are evaluated on their recognition of and ability to deal with these two or more disciplinary perspectives” (Rudgers University, 2010). Wageningen University together with its pedagogical body is among many other academic and scientific institutions which recognize the need for an interdisciplinary approach to the learning process in order to educate future scientists, managers and leaders which are able to solve complex socio-environmental problems. Furthermore, due to the nature and complexity of environmental problems, the approach is particularly recognized by universities and other institutions which offer and perform research in the field of environmental sciences (Campbell, 2005; Zarin, 2003). This contributed to an increasing number of universities that have incorporated educational programs that support cross-

disciplinary perspectives into their university curricula (Zarin et al., 2003; Rhoten 2004 in: Morse, 2007).

Another complimentary feature of the course which is actually triggered by the didactical approach is that students are challenged to develop skills to comprehend an issue from different perspectives and that only after considering all the relevant aspects a feasible solution can be designed. In the literature these skills are referred to as 'boundary crossing skills' next to domain specific knowledge, communicative and social skills (Fortuin et al., 2008). These skills are needed in order to cross boundaries both horizontally across disciplines and vertically across experts, policymakers, practitioners, and the public (Klein, 2004 in: Fortuin et al., 2008). The development of these skills is facilitated by both the fact that students come from different disciplines and that students come from all over the world thus bringing into the learning process knowledge and cultural diversity.

This paper explores the contribution of taking an interdisciplinary educational approach to the client's knowledge and capacity on UWM in Prague on the one hand and development of students' boundary crossing skills on the other. The following research questions constitute the basis of our investigation:

1. What is the value of the project results to enhance the client knowledge on UWM in Prague?
2. What is the effectiveness of the didactic model to student's development of boundary crossing skills?

Being a course that is taught at master level, the qualitative value of the EUW results are important both for the course scope, content but also for the independent client to whom the results have been delivered at the end in the form of a consultancy report. In 2010 the topic of EUW was urban water management (UWM) in the city of Prague, Czech Republic. UWM, as conceptualized in this research includes the management of water quantity and quality of the water chain and the water system including the "planning, realization, use, maintenance and monitoring of all elements of the water system as well as from the water chain" (ToR, 2010, p.1). The water chain includes household wastewater, industrial wastewater and the sewer system while the water system incorporates the natural water bodies and their relations. Thus, UWM is important to ensure "good local environmental quality, adequate infrastructural facilities […], as well as attractive green and blue areas" (Arnika in EUW 2010). Currently, a number of general problems relating to Prague's UWM have been identified. These touch upon urban water governance, infrastructure and many other domains which are interrelated with these broader problems. The research includes five districts which

together yield a more complete picture of Urban Water Management in Prague. The objective of the research was set as to provide Arnika, which is the client of the investigation, with knowledge on policy, stakeholders, technologies, ecosystems and spatial planning concerning UWM in Prague by analyzing the current state, obstacles and opportunities for improvement of these issues. Respectively, the research questions of the study were formulated across the above mentioned aspects concerning UWM in Prague.

The paper is structured into five sections. The methodology section describes the content, objective and structure of the course, elaborates in detail the features of the didactic model and the main components of the EUW. Furthermore, it explains how the data was collected, the tools that were used to collect primary data and the literature to look for the best practices on water management in different countries. Section 3 presents and discusses the project results based on the application of the didactic model and their value for the client as well as the models' contribution to student's development of boundary crossing skills. Particular attention is given to the issues concerning UWM in Prague which were compiled into the themes *Responsibilities and Communication, Infrastructure and Technology* and *Land Use Change*. Students' development of new skills was drawn upon students' individual reflection papers written half way and at the end of the course. Section 4 concludes upon the clients' knowledge and understanding of the issue and students professional skills development. The section is complemented by several recommendations concerning the didactic model and further improvements from the authors and students point of view.

2. Methodology

2.1 Course phases

In this section the structure of the European Workshop course is explained in more detail as well as the methods used to perform the UWM research. Students are forced to switch roles because of the fixed deadlines within the course. Although meeting these deadlines proves to be a considerable challenge, it forces students to focus their thoughts and maintain mutual accountability in the work they complete. Students need to communicate intensively among each other during the whole project. This is especially important because of the great variety of nationalities and disciplinary backgrounds of the participating students. In 2010, 19 different nationalities out of 30 students were counted while their study programs included environmental sciences and landscape architecture, next to a majority of students taking urban environmental management. The whole group had to work together on a consultancy assignment in order to deliver one final synthesis report about UWM in Prague.

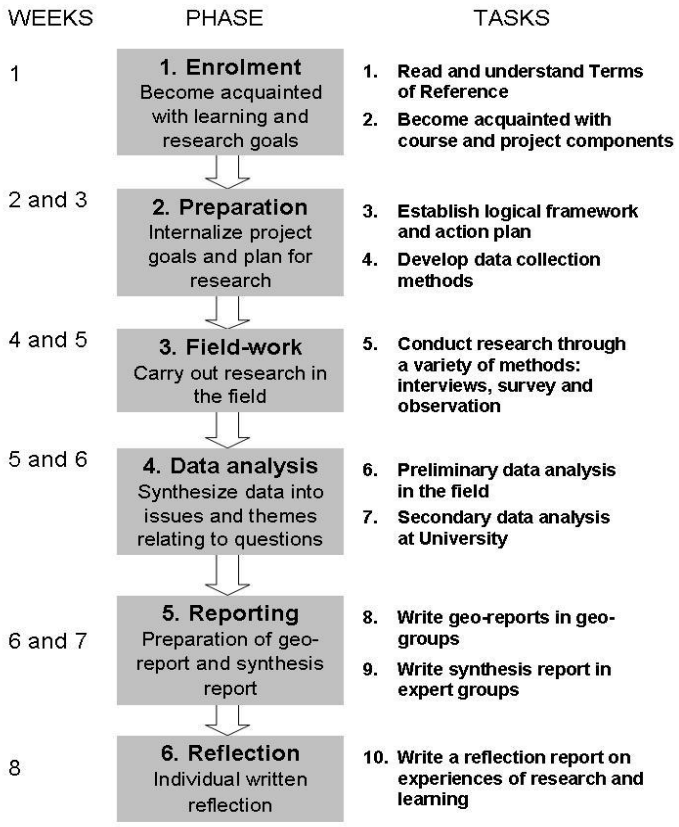

Figure 1: Timeline of phases and tasks in the European Workshop

2.1.1 Enrolment phase

In the first phase or 'enrolment' phase students receive the Assignment Terms of Reference (ToR), which guides their work as consultants throughout the course. The ToR is developed with the help of a real client (Arnika) which forces students to develop a joint formulation of the project goal and objectives.

2.1.2 Preparation phase

During the second or 'preparation' phase students have to develop research questions in five 'expert-groups' based on the following pre-defined areas: policy, stakeholder, technology and infrastructure, ecosystem services, and spatial planning. During this phase a logical framework has to be made including an action plan and data collection methods. The action plans are prepared in so called 'geo-groups', which consist of one member of each expert-group and which are responsible for doing the analyses in a predefined district of Prague. Those action plans make explicit what the responsibilities are of each participant and forms the basis of the field work to collect data on site. Within this phase students are also asked

to complete a Belbin team role assessment, making the participants aware of the different roles within a group as well as their strong and weak points. This can guide them in a better cooperation between and among other students.

The 5 districts (Prague 7; Prague 8: Karlín – Libeň; Prague 10, 11, 15: Hostivař – Záběhlice; Prague Zličín; Štěrboholy – Dubeč) were chosen by Arnika and had to be studied more in detail, because they display different urban settings which can be seen as representative for Prague's UWM as a whole. Furthermore, the developments taking place at the moment and in the near future will bring about significant changes in these districts. Urbanization, reorganization of green areas and residential areas, and the conversion of industrial areas and brownfields are major changes occurring in Prague these days. Therefore the 5 chosen districts are important for the spatial plan and urban water management.

Literature review

The first method of gathering secondary data is literature review, and is mainly done in the preparation phase. This technique is applied to get a general overview on the topic of urban water management. Review of the ToR was used to get an idea about what the client's needs were. Policy documents at different levels and from different authorities linked to water management in Prague were analyzed in order to highlight gaps and overlaps between policies. The goal was to understand how decision-making concerning Prague is carried out. Scientific documents were also used to identify the ecosystem services related to water that potentially exist in Prague. The comparison of other kinds of secondary data (e.g. land use maps, development plans, etc.) enabled the formulation of some expectations and ideas about the use of these services in the area. Technical documents were reviewed as well to obtain a first idea of the current water infrastructure in Prague. Other graphic documents such as topographic maps, zone maps, the current master plan and development plans helped to obtain a broader idea of the recent situation and possibilities in terms of spatial planning in the city of Prague. Other graphic documents such as topographic maps, zone maps, the current master plan and development plans helped to obtain a broader idea of the recent situation and possibilities in terms of spatial planning in the city of Prague.

2.1.3 Field work phase

Interview

The secondary data from the literature and websites cannot fully portray the state of policy implementation and opinions of stakeholders related to urban water issues in Prague. More

detailed information had been extracted from 25 semi structured interviews with relevant experts and authorities from different levels during the third phase: the two weeks field work. The topics for the interviews were prepared at forehand and specifically appointed to certain experts on environmental and water policy, wastewater technologies, water management and spatial planning. Interviewees are free to share not only basic or detailed information but also their opinions, thoughts and valuation about the concrete topic. Based on the free format and open-ended questions, in-depth information including the expert's professional knowledge as well as the involvement, interests and conflicts with other stakeholders were gathered to build up an overview of urban water management in Prague. During the field work data collection is mainly done by geo-groups.

Survey

Another primary data collection method applied in the field work is the survey. The questionnaires were needed in order to obtain the opinions of citizens and tourists related to water management as well as the public point of view on the strengths and weaknesses of water management performance in each district. The surveys were carried out in English and in Czech depending on the preferred language of the respondent and done both on weekdays and weekends depending on different districts. The possibility of meeting potential respondents was taking into account when choosing the places for surveys.

The survey included 29 statement questions, 2 ranking questions and 1 statement question about 14 water-related activities in the district. In the statement questions, people need to valuate the questions about urban water management performance on a Likert Scale from 1 (agree) to 5 (disagree). In the ranking questions, the respondents ranked their values on the importance of different services and topics from 1 to 5, where 1 stands for "very important" and 5 "not important at all". In the statement question the frequency of carrying out the activities were scaled by often, sometimes and never. In total, 550 questionnaires were conducted by 5 geo-groups. Most of them were done in Czech.

Observation

The third method (observation) is focused on gathering information about the actual use of the ecosystems and waters as well as citizens' behavior and valuation. In our case, we performed non-participant observations in natural settings.

Concrete information to be included in the observation framework (prepared beforehand; structured observation enables statistical analysis) is about who is using the space (number of people, gender, age), the time and circumstances of the observation (time of the day, day of the week, weather, temperature), place (land use, activities related to the place) and observed activities (sports, artistic activities, activities linked to animals, education, eating,

touristic activities and leisure). The observations were done by observing certain areas/points for 30 minutes at different times of the day and different week days (also in the weekend). In total, 105 observations were done in 5 districts in Prague.

2.1.4 Data analysis and reporting phase

Students undertook data analysis (phase 4) and reporting (phase 5) in both geo- and expert-groups during field work and on return to Wageningen University. In these phases the students are challenged to move between disciplines through meetings and collaborative writing exercises. Students are asked, again under significant time pressure, to synthesize and communicate a range of perspectives into key interdisciplinary or thematic areas (Fortuin et al., 2008).

2.1.5 Reflection phase

At two points of the course students are asked to reflect individually on their learning experience in a written assignment: first prior to going to the field, when emphasis is on enrolment, preparation and expectations and second at the end of course where they reflect on their experiences as a whole. This sixth phase is regarded as a key learning activity as it provides students with the opportunity to reflect on crossing boundaries and competencies they acquired in the workshop, such as integrating data from different sources and knowledge from different disciplines, and responding to different perspectives to the problem at hand based on disciplinary and cultural differences (Fortuin et al., 2008).

2.2 Course components

EUW Matrix

To facilitate the students' work in the course a range of components are used that aim to facilitate both research and education: the EUW matrix approach, the fieldwork in Prague, a special website, and the role of the teachers towards self-regulated learning.

A central challenge of the course is to work together with 30 students within a relatively short period of time and to produce one concise consultancy report. To facilitate the communication between all students and to clearly define responsibilities students are organized within a matrix structure (Table 1) consisting of disciplinary or expert-groups and field work teams or geo-groups. The matrix means that every field work team consists of one 'disciplinary' expert corresponding to one of the predefined areas of analysis. Each team has a Czech speaking person in order to communicate with the stakeholders in Prague. A management team consisting of representatives of all groups coordinates the work. The aim

of the matrix is to enable students to work in a disciplinary group and to deepen their knowledge and skills in a specific area of expertise (i.e. the columns of the matrix), but also forces them to cross the boundaries of their discipline (i.e. the rows of the matrix). In doing so the matrix is designed to enable intensive group interaction and facilitates the process of jointly formulating the goal, objectives and research questions as well as team writing. In addition it aims to make the particular role of every individual participant within the whole project more clear (Fortuin et al., 2008).

Table 1: EUW matrix approach

		Expert group					
		1. Policy analysis	2. Stakeholder analysis	3. Analysis of ecosystem services *	4. Technology and infrastructure analysis	5. Spatial analysis	*Management team*
Geo group	1	S1.1	S1.2	S1.3	S1.4	S1.5 (CZ)	*S1.1*
	2	S2.1	S2.2	S2.3	S2.4 (CZ)	S2.5	*S2.2*
	3	S3.1	S3.2	S3.3 (CZ)	S3.4	S3.5	*S3.3 (CZ)*
	4	S4.1	S4.2(CZ)	S4.3	S4.4	S4.5	*S4.4*
	5	S5.1(CZ)	S5.2	S5.3	S5.4	S5.5	*S5.5*

Note: S = Student; CZ = Czech student acting as translator.

* The concept of Ecosystem Services is derived from the Millennium Ecosystem Assessment

The website

In order to assist formal communication between the students and to help them manage a range of tasks associated with the research, a special web site using MS SharePoint was developed for the course. This web site supports the organizational structure of the course and facilitates the formal exchange of information between and within the different groups. The site consists of shared document folders, a calendar and provides a notice-board for announcements (Fortuin & Bush, 2010).

Role of teachers

"The role of the teachers differs considerably to traditional lecturing. The teachers stem from different disciplinary backgrounds and provide content-related support, but also focus on team facilitation and integration" (Fortuin & Bush, 2010, p.27). They support the students in

making decisions, which is a key element in a group of 30 people. By evaluating the progress of both geo- and expert-groups, the teachers try to balance the positive and negative influence of individuals, identify leaders and encourage those who are less vocal or active (Fortuin & Bush, 2010). The teachers are mainly acting as facilitators, which mean that they provide background information on UWM and pay attention to the different processes in an interdisciplinary project. Asking questions should trigger students to enhance critical thinking and alternative views. Finally, the feedback of the teachers should encourage students to learn from each other.

3. Results and discussion

In this chapter the experiences obtained from the EUW course and the results of the EUW research are described in more detail.

3.1 Research results

In order to integrate interdisciplinary research unifying themes are helpful. They can highlight issues related to the problem, unify the analysis and serve as important communication tool to frame the complex problem of the research (Morse et al., 2010).

In our research, the following themes were formed: Responsibilities and communication, Water infrastructure and Land use change.

Responsibilities and communication

Both the policy and stakeholder expertise form the basis of this theme. Firstly, the policies on EU level, national level and local level were gathered. In Czech Republic, the policy system is top-down: the EU sets directives (e.g. Directive 2000/60/EC), River Basin Management Plans, standards, etc., which are transposed by the national government. Next in hierarchy is the local government represented by Prague City Hall which transposes and implements national policies on local level. Finally, the district level is only implementing, i.e. carrying out, policies (Nanda et al., 1996). In Czech Republic, water management competencies are fragmented among five Ministries (see Table 2).

Table 2: Overview of ministries responsibilities

Ministry	Responsibility
Ministry of Environment (MoE)	Protection of water resources, the quality of groundwater and surface water
Ministry of Public Health	(In cooperation with the MoE) determination of surface water for bathing
Ministry of Transport	Use of surface waters for navigation
Ministry of Defense	All water concerning drill grounds in the territory of military bases
Ministry of Agriculture (MoA)	Everything not included in other ministries

Source (EUW, 2010)

Several institutions are present under the current ministries. For instance, the national River Basin Management companies, i.e. state enterprise Forests of Czech Republic and department of agricultural water management are under the auspices of the MoA. The MoA administers about 94% of all water courses in Czech Republic. The residual 6% are administered by municipalities, military bases and national parks (MoA in EUW, 2010). The T.G. Masaryk Water Research Institute is an agency under the Ministry of Environment which performs studies in the field of the water protection.

On the regional level urban water management is represented by the following actors (see Figure 2). Prague City Hall is a state administration authority for the city of Prague and its responsibilities in relation to water management are stated in statutes of the capital city of Prague (2009) and the Water Act.

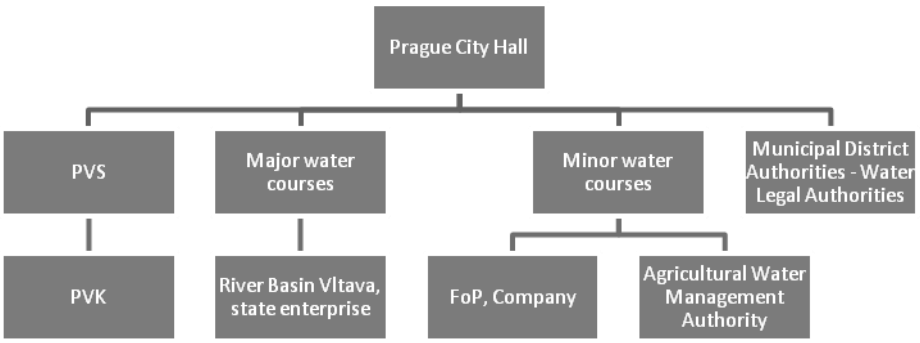

Figure 2: Responsibility Structure of Water Management in Prague

Although, Prague City Hall issues its own public notices there is only one - nr. 17/2005 Sb. – related to water management. It deals with obligatory parts of the spatial plan of the city of Prague which refer to construction regulations for floodplains. Otherwise, Prague City Hall should follow the national legislation and policies (Karnecki and Ansorge in EUW, 2010). The city of Prague is also the owner of some of Prague's water streams. Their size determines

which institution manages them. The major water courses are managed and maintained by River Basin Vltava, while the small ones are managed and maintained by Forests of Prague (FoP) and Agricultural Water Management Authority (AWMA). Prague City Hall serves as well as the competent authority when floods occur. Furthermore, the city of Prague is the owner of the water infrastructure. PVS, is the Prague Water Management Authority, has the main responsibility to keep the infrastructure in good working condition, its further reconstruction and development. PVK is the operator of the water infrastructure, e.g. production and distribution of drinking water, sewerage system and wastewater treatment, water and sewage billing (PVS in EUW, 2010). The City Development Authority of Prague (CDAoP) is a contributory organization established by the City of Prague which is responsible for the preparation and processing of strategic, urban spatial planning and territorial development documents (such as the Spatial Plan and New Spatial Plan) for the City of Prague (CDAoP in EUW, 2010). Local authorities, administrated by Prague City Hall, are responsible for the general water quality in their own districts, including drinking water, illegal discharge to surface water (streams and ponds) and ground water. Once the quality of water bodies does not reach the standards of the national law, the local authorities are responsible for recovery and monitoring.

The fieldwork to Prague revealed cases where incoherence between certain parts of national legislation and weak cooperation between UWM authorities affect negatively the urban water governance in Prague. One of the primary issues is that due to unclear definition of responsibilities concerning UWM in the national policy acts, environmental lobbyists are of less influence than agricultural and industrial lobbyists which put environmental protection issues on the second place after those of economic nature (Dvořák in EUW, 2010). Second, is the fact that cooperation exists only between certain institutions which disrupt the integrated approach to UWM problems. An example is the cooperation between Prague City Hall and FoP in terms of management, maintenance and revitalization of small water courses where T.G.M. Water Research Institute, which is a scientific research and has important theoretical knowledge on the matter, is not consulted for advice. Finally, is the decision making process and the consultation with parties: government - non government - citizens concerning UWM projects and other water related developments. In the opinion of Karnecki (Karnecki in EUW, 2010), there are no future plans for public participation in projects on urban water because Prague City Hall perceives it as a cause of problems and delays. These explain the fact why 59.5% of the survey respondents think they do not “interact with authorities and decision makers on urban water issues”.

Water infrastructure

The results regarding urban water infrastructure and management are divided in drinking water, sewer system and wastewater treatment plant, storm water and flood protection management. Drinking water in the city of Prague is supplied from three main sources (see Table 3).

Table 3: Characteristics of the main drinking water sources in Prague

Water source	Type of source	Supplied (%)	Distance from Prague	Max capacity(L/s)
Želivka (1972)	Surface water from Želivka reservoir	75	52 Km.	6900
Káraný (1914)	Undergroundwater+ infiltration from the Jizera River	25	23 Km.	1750
Podolí (1929)	Surface water from Vltava River	Reserve	0 Km.	2200

Source (EUW, 2010)

The city is connected to a central drinking water system (Veselý in EUW, 2010) operated by Veolia. The coverage in the distribution network in Prague is 99.5% approximately 1.230.000 inhabitants. In 2008, the total production of drinking water was 125 mil.m^3, with a domestic consumption of 122 L/day per cap (Kinkor in EUW, 2010). According to Bílek et al. (Bílek et al in EUW, 2010) and Veolia, the quality of drinking water meets the European standards in terms of physical, chemical, microbiological and biological parameters. Two types of sewer system are currently in use in the city of Prague. Combined sewer system (mixed wastewater and rainwater in the same pipe) is used in the historical centre. Separated system is used in the rest of Prague and also considered for the new settlements.

The sewer system consists of 3691 Km of network, 919 km of connections (branches) and 263 pumping stations (Kinkor in EUW 2010). Major part (95%) of the wastewater collected in the sewer system is treated in the Central Waste Water Treatment Plant (CWWTP) located at the Císařský Island in Prague 7. Remaining 5% is treated in 21 local waste water treatment plants located at the peripheral areas around the city which will be closed in the near future (Pospěch and Kinkor in EUW, 2010). The CWWTP uses mechanical biological treatment. The digested sludge produces biogas that surplus 75% of the energy required by the plant (Pospěch in EUW, 2010). The current CWWTP cannot achieve the limits for the

removal of nitrogen in accordance with the EU requirements, thus a new line of treatment with more advanced technology is planned to be constructed in near future (Bouček in EUW, 2010). Regarding to the storm water system1, majority of the areas in the city of Prague has no water retention, infiltration and reuse facilities as identified by Dostál (Dostál in EUW, 2010). Generally, the combined sewer collects all the surface runoff and transports it to the central WWTP. Exception is Trojmezí area where part of storm water is stored in recreation ponds and Zličín area where storm water is captured by separate sewer system and canals and then transported to the river Vltava without treatment. It is considered that the city of Prague is protected from flood of five hundred years (Q500) after flood of 2002 and other main rivers are prepared for flood of hundred years (Q100) (Rychtecký in EUW, 2010). Existing flood protection measures include vertical embankments on the bank of Vltava River, movable anti-flood barriers, reservoirs, dykes, dams and some flood plains.

The main problems concerning water infrastructure relate to the state of sewer system in certain parts of Prague which is old and affects the quality of water and overall management of the system, WWTP nitrogen removal which is not line with the EU and national requirements, under capacity of rainwater retention and problems around the management of decentralized WWTP. In order to address these problems, investment and cooperation between national and local authorities is needed.

Land use change

This third theme is mainly a combination of the ecosystem services expertise and spatial planning expertise. Three land use changes will take place according the new Master Plan. It is important to take the decreasing infiltration capacity and the ecosystem services into account when changing agricultural lands into mixed urban land use (residential and service). High surface runoff of storm water, change in water quality and change in the biodiversity could be problems in the future. When changing brown fields[2] into mixed urban areas, it is important to take the increasing water consumption into account. New water services should be constructed as well. The third change is the creation of flood prevention zones and buffer

[1] Stormwater is water that accumulates on land as a result of storms, and can include runoff from urban areas such as roads and roofs. Stormwater management is the management of stormwater runoff, often using water retention facilities, to provide controlled release into receiving streams.

[2] Real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

zones on current open spaces. This has positive effects on the providing functions of ecosystems and reduces the flood risk in surrounding areas. However it reduces the amount of land that can be used for urban development. According to the survey, citizens living in the districts near the Vltava River do not think that their area is safe from flooding compared with the suburbs. The construction of flood prevention zones and buffer zones can contribute to a safer perception of flooding by the citizens. The willingness to pay for flood protection facilities by citizens is however low in the whole of Prague. For the future regional development the ecosystem services should be taken into account in order to avoid future water issues as well as the importance of nature development. It is noticed that there is a difference between the concerns on ecosystem services of citizens compared with experts. Citizens also valued nature as most important topic for future development followed by education and culture. Recreation and sport are valued as less important for future developments. The use of different ecosystems is recommended to be taken into account when constructing new urban areas. Activities along the ponds cover primary leisure, on second place sport and almost no cultural or educational activities. Near the river, sport is the most important activity, followed by leisure and culture and education. Similar data is obtained for parks, but here with strong emphasis on leisure and sport and nothing for education (EUW, 2010).

Value of didactic model for the research results

The field work to Prague identified the main problems related to UWM, helped to clarify what are the roots of these problems and what are the possible solutions. Due to the application of the innovative didactic model based on an interdisciplinary approach, the problems and respectively the solutions where comprehended from all perspectives, taking into consideration the variety of such factors as EU polices in the field of water, stakeholders role, the state of the current and future city developments, existing infrastructures and spatial development plans. These led to project results being comprehensive but at the same time with sufficient in-depth information. Thus, the client has been provided with an ample analysis concerning UWM in Prague which can be used to trigger the most central UWM problems in an integrated way.

3.3 Didactic model and students boundary crossing skills development

For most of the students it was the first time that they were part of two or even more groups at the same time. This resulted in reflections like *"Team work is important in each activity in Prague. The task facilitates me to learn how to be a part of a team"*. Another student

mentions in his reflection report the value of being in two groups at the same time: *"when crossing within expertise and geo groups, I could learn not only from own experience, but also from the experience of the other members and information they gathered".*
The EUW matrix functioned as an organizational support which in the end creates an overall picture: *"the structure enabled cooperative integration of all issues. When working in geo group we could concentrate on specific area and devote sufficient time for its exploring by observations and other methods as questionnaires and surveys. After being acknowledged about problematic in concrete districts as geo groups we could further see the links and differences in various areas when coming back in expert groups. This allowed a more coherent picture of the situation"*. Such an approach enables cooperative integration of all kind of issues, creates synergy in the work and makes it possible to work together in such a large group of students.

Another learning experience was obtained from the variety of nationalities and different cultures. The whole group faced so-called 'individual bridges and barriers' (Morse et al., 2007). Personal characteristics such as creativity, risk taking, flexibility, cross-disciplinary thinking, dedication and problem solving influences the research. It requires patience to deal with these issues and to create a common vision. Some students mentioned the better understanding of their personal attitude as a result of this course. The communicative and organizational skills are mentioned by almost all students. This can be pointed out by the experience of a student who describes this workshop as *"a speed course in communication skills"*. Another student states that *"I have now better knowledge how to communicate with people from public but also from professional sphere"*. These communication skills are found quite important. According to a student *"the relationships with teachers and other students including me are close, encouraging, and motivating. In my opinion, this is why relationships, participation and team work of all students are the most important factor in determining the success of the project".*

While developing the research questions and the logical framework, the so-called "disciplinary bridges and barriers" became more visible (Morse et al, 2007). Terms were used with different definitions causing confusion and discussions among the group members. Common scales and units were discussed in order to use them for the observation frame and survey. In other words the group had to use the same "language" in order to come up with a framework including all the different expertise and data.

In order to understand the individual and disciplinary bridges and barriers, the Belbin test has been used. This test focuses on the identification of different team roles in a group in order to find the strengths and weaknesses and to cope with them. The field work provided a chance to test theories, constructed during the preparation phase, into practice. Same goes with the students' expectations. *"Moreover I consider field work as valuable element as it gives an opportunity of applying knowledge gained during studies and actually supports learning by doing".* The differences between theory and practice were discussed in plenary and in small groups in order to deal with the experienced changes. Students realized the importance of the preparation period as well as the flexibility to overcome unexpected circumstances. The data collection methods (interviews, surveys and observations) needed some adjustments in the field. For example, the observation frameworks did not take into account all the existing ecosystems as well as the interpretation of activities related to sport, leisure, culture or education. The two weeks of field work resulted in a more intensive cooperation between students. Several conflicts took place, but also new relationships were formed. Students were able to getting to know their fellow students better. Having students in the group who were able to translate and communicate in the Czech language appeared to be crucial. They often provided guidance in Prague. The connection between reality and theory is given by the following statement: *"I value the fieldwork quite high because all the time you have to make decisions and to find the optimum for your research. It is a good opportunity to work with time, money and information constraints"*. Another student points out the consequences of this time pressure: *"because of the time limitations we could apply some of the tools only partially".*

During the fieldwork, 25 interviews were performed creating opportunities to improve the students' interviewing skills. *"During the fieldwork I have gained more experience with interviewing (…) making a topic list for open ended interviews forces you to focus exactly on what you want to know".* The same goes for collecting surveys and observations.

The EUW Matrix approach has proven to be successful in organizing 30 students with different cultural and disciplinary backgrounds in one project team. It provided a clear overview of who is responsible for or involved in certain activities. Switching between the different (geo- and expert-) groups contributed to the learning experience to deal with disciplinary knowledge, team roles, cultural backgrounds and personalities. Some students find the matrix approach limiting their ideas and approaches as well as the pre-defined disciplines. However, working without the matrix was not preferable.

The overall value of the course was positive. One student stated: *"I learned a lot for my personal attitude, skills, knowledge and my organizational skills to work with others as a team"*. Working for a real client was mentioned several times as being motivating as well.

"Thinking collectively about complex problems requires crossing boundaries both horizontally across disciplines and vertically across experts, policymakers, practitioners, and the public" (Klein, 2004 in: Fortuin et al., 2008). Students were challenged to cross boundaries between theory and practice by means of the fieldwork, between disciplines by means of the expert-groups and between cultures by means of working in this international group. The students are challenged to develop other skills to improve the communication, collaboration and integration within such a group.

4. Conclusions and recommendations

Below conclusions and recommendations are presented based on the two research question that we inquired by the paper authors.

1. What is the value of the project results to enhance the client knowledge on UWM in Prague?

EUW, as a course with an interdisciplinary approach, contributes effectively to the MSc Program Urban Environmental Management aims and learning outcomes. The course endow students with knowledge and skills to understand the urban environment together with its infrastructure, economic, social and political factors, technological possibilities and limitations as well as to integrate these into realistic environmental management strategies and implementation programs which can be further used by government, business and non governmental organizations. As a result, the client of the EUW project was delivered an ample synthesis report which presented and discussed the current and future possible developments of the urban water sector in Prague from the sustainability point of view. Based on the main findings and best practices from the urban water sector from all over the world, the client was provided with a range of recommendations. First of all, it was concluded that communication and cooperation should be improved, therefore, the client was recommended to launch annual meetings, publications, website or forums for all relevant organizations concerning the current and future plans in are of UWM. The client was suggested that the strategy could also be used to increase the public involvement in decision making in Prague. With respect to the infrastructure, in particular storm water management, it was recommended that the current city expansion could take into account the retention

capacity of water bodies and incorporate this into future planning. From the spatial planning perspective it was recommended to embrace a more holistic approach to sustainability and take into consideration different systems that correlate in the region. Because of the particularity and specific characteristics of the different areas of Prague, the design of the new developments should focus on a regional scale. In terms of waste water treatment it was recommended to strengthen national legislation in accordance with the EU directives, further enforce polices implementation and develop national incentives for farmers not to use fertilizers on the fields located near streams. It was also recommended to use source separation of rain and wastewater. Local water sources like in Zličín should be promoted and protected and further studies should be carried out to determine the capacity to satisfy future demands. In order to ensure protection of environmental components, such as quality of surface waters, it was recommended to technically update the existing central WWTP and improve the treatment efficiency of the existing decentralized treatment plants. This requires stakeholder's awareness of technical knowledge and innovations, financial support, political acceptance and public support. One option for the future is to reduce the water consumption by storage and reuse of storm water. This will help to minimize the hydraulic peak loads and flood risks, control the pollutants in the discharged water, reduce the volume of waste water to be treated in the central WWTP and provide supply for the irrigation of green areas. The Synthesis Report addressed all the above findings and recommendations in more detail so that the client could comprehend the full extend of the issues and the factors involved. It is important to mention that this was only possible due to the interdisciplinary approach the course applied to the learning process and the didactic model itself.

2. What is the effectiveness of the didactic model to student's development of boundary crossing skills?

EUW course provides a framework to educate students in doing interdisciplinary research dealing with deadlines (time), different characteristics of the work (in depth or broad) and limited (informational) sources. Students are stimulated to practice their interview skills, organizational skills and communicational skills. They practiced decision-making and negotiations as well as being flexible and critical. At the same time they are confronted with their personal attitude, skills and knowledge and time limitations. Students are more aware of the different personal perspectives and disciplines that exist. Also cultural differences have been noticed. In these ways horizontal boundaries are crossed. The fieldwork contributed to create awareness of the difference between theory and practice. In these ways the students overcome the horizontal boundaries across disciplines. Students experienced unexpected situations in which they are forced to show more flexibility in order

to deal with uncertainty. The vertical boundaries across experts, policymakers, practioners, and the public are made aware during the project as well.

The same qualities and threats within interdisciplinary research which are faced by students apply for the teachers (Morse et al., 2007). In addition they should already have some experiences with interdisciplinary research in order to provide proper guiding. In the EUW course the teachers were acting as a facilitator instead of instructor. The teachers stimulated the students to think critically by asking questions and providing tools rather than just instructing them. They stimulated the research process, while students were ultimately responsible for the results. Most students favored this kind of guidance throughout the process, and acknowledged the advantages of 'learning by doing' rather than by 'being instructed'.

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