# Experiencing the Research-Based Learning: Case of the graduate course "Landscape Perspectives in Disaster Risk Management and Fire Safety"

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## ABSTRACT

This paper presents the research-based learning (RBL) experience in the graduate course "Arch451-Landscape Perspectives in Disaster Risk Management and Fire Safety". This experience relied on the principle "the student as researcher and the lecturer as moderator of the process". The research teams consisted of four students. The study areas were the metropolitan regions of Skopje, Novi Sad, Banja Luka, and Tirana. First, the students were introduced into the main theme of wildfire risk within wildland urban interface (WUI). The group discussions during class meetings were helpful in shortlisting the set of criteria implicated either with wildfire ignition or spreading regimes. Similarly, the weighted impact factor of each criteria was defined as average values of all participants via analytic hierarchy process (AHP) pairwise comparison method. Each group performed their GIS-based analysis for their specific study area following the same method that have been developed in the first part of the process. At the final stage, each team delivered a technical report and a poster presenting their research work and original findings about their specific study area. As a result, the RBL process enabled the students to experience a participatory research process that contributes to the enhancement of their teamwork and research skills.

***Keywords**: project-oriented research, wildfire, GIS, teamwork, EPOKA University*

## INTRODUCTION

The quest for new methods in teaching that goes beyond knowledge gaining is not new. Many scholars have denounced the conventional instructions failure to prepare professionals that thinks critically [1]. The origin of the discussion is based on the student-engagement theory pioneered by [2-6]. Pike and Kuh (2005) [7] have performed an evaluation of the 30-year experience of student-centered university transformations in USA. They have defined six student-engagement types based on the profile of the higher education institution. For example, the collaborative one, promotes teamwork where peers depend on and support each other. Yet, they are continuously supervised by the faculty in a campus environment supported by technological means. This is the closest definition of the student-engagement type as experienced in Arch451 course.

This paper presents the research-based learning (RBL) experience in the graduate course "Arch451-Landscape Perspectives in Disaster Risk Management and Fire Safety". Arch451 is among the elective courses within the professional master (PM) program in Disaster Risk Management & Fire Safety (DRM&FS) in the department of Civil Engineering at EPOKA University. The PM program opened within the goals of K-Force Erasmus+ capacity building project. Twelve graduate students have been enrolled to the course and have actively participated in the RBL process during spring semester 2018-2019.

The landscape dimensions of fire safety theme expands towards the topic of wildfires. Despite the benefits that natural wildfires provides to regenerative cycles of many biomes on earth [8], if not controlled they can be severe threat to many endemic species and humans. The wildland urban interface (WUI) are

the hybrid territories where the natural lands and the human settlements meet, thus the forest fire risk is the highest.

The wildfire regimes are expected to change drastically in the upcoming decades affected by the consequences of global warming and climate change. The fire season in the southern Europe is projected to be stretched in time (within a year) and the wildfire events more frequent [9]. Thus, the assessment of wildfire risk within the WUI zones of western Balkans as Mediterranean regions is crucial. This was the main motivation of the RBL process design within Arch451 course.

## DESIGNING THE RESEARCH-BASED LEARNING PROCESS

First, the students are presented the draft work-schedule of the semester and are invited to discuss on the draft for further improvement. Figure 1 presents the main work-packages to be performed during the semester and their time-lapse within the process. First, the students were introduced basics of wildfire phenomena in the landscape to have a general understanding on the main theme. Then, the group was organized into three groups of four members each. The students were free to select their peers. In principle they were free to make the task distribution within the group. The role of the lecturer was a mediator when needed.

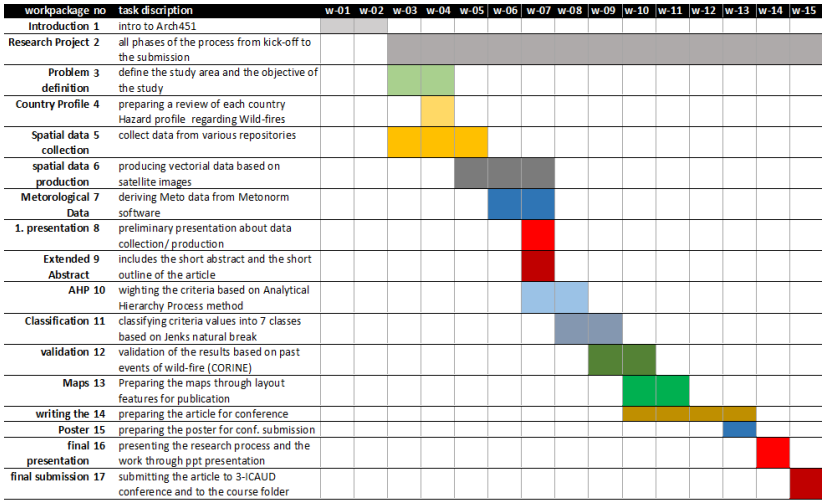


Figure 1. The work-schedule of the semester defining the main stages of the work.

First the participants have been presented a series of introductory short lectures on natural hazards and specifically the wildfires. A further focus of the presentations targeted the forest fire risk within the wildland urban interface (WUI). Apart from the general information on the problem definition, the students are introduced into the importance of GIS technology in dealing with the wildfire issue. There are a variety of forest fire risk assessment methodologies that are prepared using GIS technologies. This introduction aimed to provide a general understanding of the problem and the available tools for developing solving means.

The first task of the groups was the preparation of the national forest fire hazard profile of the specific study area. They have been delivered an assignment sheet as shown in Figure 2. The groups were asked to scan the available literature including published articles, reports or statistical data from reliable resources. These sources helped in collecting information about the fire regimes, major wildfire events, major causes and effects of fire events in the specific context. This task was meant to contribute to the contextual understanding of wildfire in the specific study area. At the same time, the results of this task could be very easily adapted as the “Study Area” part of the final report.

| | |
|---|---|
| **Epoka University** | Department of Architecture |
| spring 2019 | **Arch 451 _ Landscape Perspectives in DRM & FS** |
| instructor | Artan Hysa |
| Exercise 01 | **National Forest fire Hazard Profile of your Study Area** |
| brief | The aim of this exercise is to become familiar with the available sources on inventory data and monitoring programs on DRM & FS with an emphasis on wildfire and forest fire hazard. You are expected to search on online national and international platforms dedicated to hazard monitoring and prevention.<br><br>As a group, you are assigned to prepare the Disaster Risk profile of the Country of your study area, based on the Hazard type; wildfire and Forest Fires. This is the preliminary work of your group research project, specifically about the part explaining the study area.<br><br>The report may include, the fire regimes, major events, major causes and effects of wildfire events in your case country as well as the focal study area. |
| **Format** | Report, about 5 pages (including the images), a title page including all info about the course and the task. |
| **Evaluation** | 5 % of the term-grade |
| **Due time** | Monday [25.03.2019] @ 23:00 o'clock |

Figure 2. The task of "Country profile" about wildfire phenomena.

## Study Area

The metropolitan areas of Tirana, Skopje, Novi Sad, and Banja Luka are selected as the study area of process. All study areas are the urban centers where the K-force project partners are located, and their Urban Atlas data of 2012 were available. Tirana is selected as the demonstrative case and is handled by the instructor of the course during the explanatory tutorials. While other study areas are distributed one per group as shown in Table 1. The final selection of the specific study area was based on negotiations among groups.

Figure 3 shows the geographical location of all four metropolitan areas within the western Balkans region. Tirana and Skopje represent the capital metropolitan areas of Albania and Northern Macedonia. While Novi Sad and Banja Luka consist of secondary metropolitan areas of Serbia and Bosnia & Herzegovina. Yet, the available Urban Atlas (UA) data define similar in size metropolitan boundaries for the selected cities. The average total surface area of the selected study areas is about 2000km$^2$.

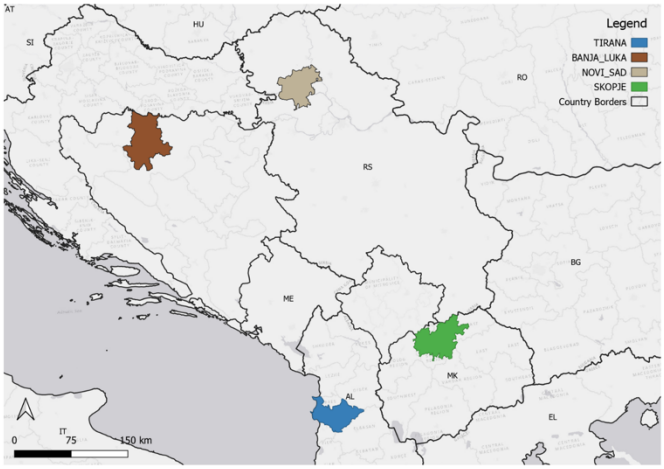


Figure 3. The study area including the metropolitan areas of Banja Luka, Novi Sad, Skopje, and Tirana.

The RBL process relied on a workflow consisting four stages and 7 steps as shown in Figure 4 following the model developed by [10]. The second stage is the inventory one, where all quantitative measurements are collected for each criterion. This stage followed the multi-criteria inventory method developed by [11].

| | | Goal | Method |
|---|---|---|---|
| **Preliminary work** | **1** | Identification of the Study Area within the protected Area | Identification of the vegetated natural surfaces from CORINE Land Cover data |
| | **2** | Data conversion | Shapefile to Raster (pixel size 250 m) |
| | **3** | Generate the point cloud of pixel centroids | Raster to Points operation |
| **Inventory** | **4** | Multi-criteria inventory | Calculating the values of all criteria for each point |
| **Analyses** | **5** | Data clustering | Clustering the values of each criteria into 7 classes according to Jenks natural breaks reclassification method via ArcGIS |
| **Indexing** | **6** | Calculating WIPI | Raster calculator (equation 1) |
| | **7** | Calculating WSCI | Raster calculator (equation 2) |

Figure 4. The stages of the research.

Each stage is expanded into detailed procedures of GIS-based processes relevant to the goals of the specific stage. For example, Figure 5 presents detailed steps of the stage 1 of the workflow aiming data collection. Besides the demonstrative sessions explaining consecutive steps of the analysis, the students have been delivered detailed workflow steps as shown in Figure 5.

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**Checklist of Process Steps**

| | | Task | Method | Time |
|---|---|---|---|---|
| 1 | | **DATA GATHERING / PRODUCTION** | | **>100 min** |
| | A | **Urban Atlas (UA)** | **Vector data** | **45 min** |
| | *a* | Download UA of study area | Copernicus website | ~70mb |
| | *b* | Familiarize with/ visualize UA data | Free activity | 10 min |
| | *c* | Extract Forest surfaces from UA | Attribute table/ Select by expression | 5 min |
| | *d* | Create Reference Points (100m) | Vector/ research tools/ regular points | 5 min |
| | *e* | Extract points within the forested areas | Vector/ research tools/ Select by location | 5 min |
| | *f* | Extract Urban Centers (S1) | Attribute table/ Select by expression | 5 min |
| | *g* | Extract Settlements (S2) | Attribute table/ Select by expression | 5 min |
| | *h* | Extract Agricultural Land surfaces (S5) | Attribute table/ Select by expression | 5 min |
| | *i* | Extract Water surfaces (P4) | Attribute table/ Select by expression | 5 min |
| | B | **Digital Elevation Model (DEM)** | **Raster data** | **25 min** |
| | *a* | Download the DEM tile | Copernicus website | ~5 gb |
| | *b* | Extract the DEM of study area | Raster/ Extraction/ mask layer by UA boundary | 5 min |
| | *c* | Familiarize with/ visualize DEM | Free activity / generate Contour lines | 5 min |
| | *d* | Generate SLOPE values from DEM (P1) | Raster/ Analysis/ Slope | 5 min |
| | *e* | Generate ASPECT values from DEM (P2) | Raster/ Analysis/ Aspect | 5 min |
| | *f* | Generate ALTITUDE values from DEM (P3) | | 5 min |
| | C | **Environmental Data** | **Raster data** | **20 min** |
| | *a* | Download data | Surfobs/ climate/ Copernicus | ~5 gb each |
| | *b* | Maximum temperature tile | Surfobs/ climate/ Copernicus | 5 min |
| | *c* | Precipitation tile | Surfobs/ climate/ Copernicus | 5 min |
| | *d* | Pressure tile | Surfobs/ climate/ Copernicus | 5 min |
| | *e* | Extract info by study area | Raster/ Extraction/ mask layer by UA boundary | 5 min |
| | D | **Open Street Map (OSM)** | **Vector data** | **10 min** |
| | *a* | Download OSM data | OSM / Geofabric.de | ~50 mb |
| | *b* | Extract Main Transportation (S3) | Attribute table/ Select by expression | 5 min |
| | *c* | Extract Any Road (S4) | Attribute table/ Select by expression | 5 min |
| | E | **Manually Generated** | **Vector data** | |
| | *a* | Power lines | Create shapefile | |
| | *b* | Fuel Stations | Create shapefile | |
| | *c* | Dump Areas | Create shapefile | |

Figure 5. The detailed steps of the stage 1 of the workflow aiming data collection.

During the process, the students are asked certain pop-up assignments in order to fulfill important steps of the research. For example, Figure 6 presents the assignment that aimed the extended abstract. It was meant as an individual brainstorm in order to explore the personal potentials on drafting a research paper structure. Later these individual outputs were merged among the members of the group into a common paper draft. This assignment was organized as a take-home Mid-term exam.

The second half of the semester consisted of an intensive GIS-based work to perform the analytical steps according to the predefined plan. Within the steps of the workflow (see Figure 4.) there have been delivered some minor assignments. For example, the absolute values measured during the inventory phase needed to be reclassified into relative sub-classes. We decided to use the Jenks natural break normalizing method which targets the minimum diversity within a certain class and maximum difference among the classes.

| Mid-term submission | | **Research Proposal / Extended Abstract** | |
|---|---|---|---|
| *task* | | *about* | *point* |
| *Question* | *1* | *Please, propose a tentative title for your term paper. It may indicate the main topic and focus, method, study area.* | *5* |
| **Title of the Paper** | | | |
| *Question* | *2* | *Write the draft abstract of your research. Try to shortly indicate the goal and objective, study area, methods and tools used, expected/ preliminary results, and the impact and contribution (up to 300 words). Conclude with 5-7 keywords.* | *15* |
| **Abstract** | | | |
| *Question* | *3* | *Please indicate the goals and objectives of your study. Indicating its relevancy and its contribution in the field of DRM&FS. (references are appreciated)* | *10* |
| **Goals and objectives** | | | |
| *Question* | *4* | *One paragraph summarizing the forest fire phenomena globally (refer to 3-4 sources).*<br>*Another one summarizing the factors affecting the fire regimes in general and specifically in Mediterranean. (refer to 3-4 sources) try to differentiate between factors in terms of their relevancies to the ignition and spreading phases of a forest fire.* | *15* |
| **Literature Review** | | | |
| *Question* | *5* | *Please, explain shortly the methods, techniques, software, plugins you have used in different phases of your work. Graphics/ charts/ tables showing the workflow of the process and the methods used are more than welcome. The technique is free.* | *15* |
| **Procedure & research steps** | | | |
| *Question* | *6* | *Please, explain shortly the raw materials you have used. Indicate the way you collected. A table showing the materials and the way of acquisition (sources) is more than appreciated. (include sources in the references list as well)* | *10* |
| **Materials** | | | |
| *Question* | *7* | *AHP in this study is used to generate the impact factor each criteria would have in reference with their relevancy to either ignition or spreading of a forest fire. Please explain in one paragraph AHP method in principle and its specific use within this work. (2-3 references are expected)* | *5* |
| **Analytical Hierarchy Process** | | | |
| *Question* | *8* | Please explain in one paragraph natural break (Jenks) classification method. And, briefly explain its utility in this study. *(2-3 references are expected)* | *5* |
| **Jenks natural break** | | | |
| *Question* | *9* | *Please, explain the expected results from this study. What type of materials you are going to produce and deliver. Present preliminary results; tables, maps, statistics, etc.* | *10* |
| **Expected/ Preliminary Results** | | | |
| Question | 10 | Please list all references included in the previous answers. In total the list should consist of relevant 15-20 references from articles or books in the field. | 10 |
| **References** | | 1. | |
| Total GRADE | | | 100 |

Figure 6. The structure of the take-home Mid-term exam.

Figure 7 presents the Jenks natural break reclassification task. After a common demonstrative session based on the case of Tirana, the students have been provided detailed instructions about the steps to follow. The procedure was expected to be performed to the absolute inventory records of all defined criteria. They have been asked to perform the analysis for their specific study area and discuss the results with their group members.

Reclassifying by
**Jenks Natural Break**

| **Step** | | **Explanation** |
|---|---|---|
| Import Reference points layer | **1** | The layer which includes all values of 13 criteria |
| Open attribute table | **2** | Toggle editing mode |
| Remove all "null" values | **3** | Select by expression: "field" is null / select & delete |
| Generate breaking values | **4** | Layer properties/ symbology/ Graduated/ Jenks natural break/ 10 classes |
| Remember breaking values | **5** | Snipping tool |
| Reclassify according to breaking values | **6** | Field calculator / create a new field / expression (example):<br>*CASE*<br>*WHEN "S1-urban c" > 24570.94 THEN '1'*<br>*WHEN "S1-urban c" > 19989.89 THEN '2'*<br>*WHEN "S1-urban c" > 16050.22 THEN '3'*<br>*WHEN "S1-urban c" > 13081.63 THEN '4'*<br>*WHEN "S1-urban c" > 10766.24 THEN '5'*<br>*WHEN "S1-urban c" > 8371.39 THEN '6'*<br>*WHEN "S1-urban c" > 6128.92 THEN '7'*<br>*WHEN "S1-urban c" > 4169.67 THEN '8'*<br>*WHEN "S1-urban c" > 2281.07 THEN '9'*<br>*WHEN "S1-urban c" > 0 THEN '10'*<br>*END* |
| Save changes | **7** | Finalize reclassification for all criteria |
| Close editing view | **8** | Finish the work |

Figure 7. The task of clustering the inventory values into 7 classes via JNB.

## RESULTS

At the final stage of the semester the groups were expected to organize the work distribution among group members to prepare the final submission. Table 1 presents the task distribution among group members for each cases study. Responsible members had to submit their term work in four main packages. The paper or the technical report was meant as the written material of the submission (following the academic writing standards).

Table 1. Responsibility distribution among group members.

| | paper | maps | presentation | poster |
|---|---|---|---|---|
| **Skopje** | Iza or Eriola | Besmir or Iza | Eriola or Behar | Besmir or Behar |
| **Novi Sad** | Endrita or Fatma | Endrita or Fatma | Marjana or Terens | Marjana or Terens |
| **Banja Luka** | Izet | Dritan | Tanush or Klajdi | Tanush or Klajdi |

Second, each group had to prepare a poster which had to be printed and graphically present all parts of the research. Furthermore, a presentation (PowerPoint) was required in order to structure the final group presentation during the final review meeting. The groups have been asked to submit a series of maps being prepared according to the professional standards of mapping techniques.

Table 2 presents the detailed explanation about the tasks and the required skills. The group members were asked to agree among each other on task distribution according to their personal skills and availability. For example, for the paper task the responsible person had to be experienced in academic writing standards, being proficient in written English as well as having written at least one conference paper before.

The group member that would deal with the maps must have relatively more experience in using GIS for mapping. Although all students was trained to produce qualitative maps within the objectives of the course, some of them has continuously used the GIS technologies in their professional works as well. While the tasks of PowerPoint presentation and the poster (see Figure 8 for a sample poster) required digital graphical experience. Some groups decided to share specific tasks among two group members as shown in Table 1.

Table 2. The detailed explanation and the required skills for the final work packages.

| task | explanation | required skills |
|---|---|---|
| Paper/ Article | * The first step is to merge 4 extended abstracts into 1, by including the most relevant parts of each and avoiding repetition of information. | * good academic writing skills |
| | * prepare the paper in a conference paper format/ outline. | * proficiency in English |
| | * All other members are expected to contribute via the shared Google Docs file | * having been writing a conference paper before |
| GIS maps | * Prepare a set of maps of the study area from the layers you have worked and produced. (PDF or image) | * experience in GIS mapping |
| | * among them you may include; basic map of study area, raw layers classified by Jnb, WIPI-WSCI, etc. | * experience in digital graphics |
| | * These maps will be the main graphical material for the paper, presentation and poster. Thus the soonest they are produced the better. | |
| Presentation | * a ppt presentation explaining the process of the research, materials, results, etc. | * experience in PowerPoint presentations |

| | | |
|---|---|---|
| | * Think this work as the presentation of the group work in a conference, where you are going to present to an audience that know nothing about your research. | * experience in digital graphics |
| Poster | * is the visual representation of the research process. | * moderate knowledge of any graphic software (Photoshop, Corel draw, illustrator, other) |
| | * you can consider as the poster presenting the group work in a conference in a poster format (no oral presentation), where you are going to show to an audience that know nothing about your research. | * experience in digital graphics |

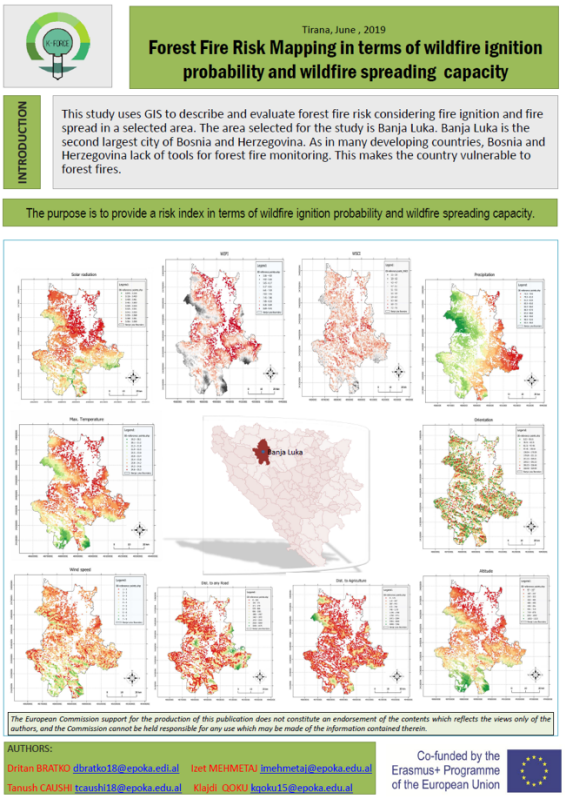


Figure 8. Poster submission of Novi Sad case, by Bratko, Mehmetaj, Caushi, and Qoku.

Fostering peer-review and peer-evaluation as a tool of transparency and responsibility in the grading system.

Figure 10 presents an image from the event of the final review presentations. The students participated as jury members as well by grading the presented works. Figure 9 presents the peer- review table delivered to each student during the final presentations. Each member was requested to evaluate each presentation following the delivered template. The questionnaire included evaluation of each task separately for paper (report), presentation, maps series, and poster. The evaluation was based on a Likert scale scoring instead of numerical grade. The peer-evaluation was transformed into numerical values by the instructor.

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**FINAL Peer-Review**

| Case | Work-package | | | | | |
|---|---|---|---|---|---|---|
| 1 Skopje | Behar<br>Besmir<br>Erida<br>Iza | Very Poor | Poor | Good enough | Very Good | Excellent |
| | *Paper* | ☐ | ☐ | ☐ | ☐ | ☐ |
| | *Presentation* | ☐ | ☐ | ☐ | ☐ | ☐ |
| | *Maps* | ☐ | ☐ | ☐ | ☐ | ☐ |
| | *Poster* | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Novi Sad | Endrita<br>Fatma<br>Marjana<br>Terens | Very Poor | Poor | Good enough | Very Good | Excellent |
| Endrita | *Paper* | ☐ | ☐ | ☐ | ☐ | ☐ |
| Fatma | *Presentation* | ☐ | ☐ | ☐ | ☐ | ☐ |
| Marjana | *Maps* | ☐ | ☐ | ☐ | ☐ | ☐ |
| Terens | *Poster* | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Banja Luka | Dritan<br>Izet<br>Klajdi<br>Tanush | Very Poor | Poor | Good enough | Very Good | Excellent |
| | *Paper* | ☐ | ☐ | ☐ | ☐ | ☐ |
| | *Presentation* | ☐ | ☐ | ☐ | ☐ | ☐ |
| | *Maps* | ☐ | ☐ | ☐ | ☐ | ☐ |
| | *Poster* | ☐ | ☐ | ☐ | ☐ | ☐ |

Figure 9. Peer review form filled by each student during final presentation

Figure 10. Presentation of Novi Sad case, by Bratko, Mehmetaj, Caushi, and Qoku.

## CONCLUSIONS

This paper presented the research-based learning (RBL) process as experienced in the graduate course “Arch451- Landscape Perspectives in Disaster Risk Management and Fire Safety”. Arch451 course opened within the curricula of Professional Master Program in Disaster Risk Management and Fire Safety in the department of Civil Engineering at EPOKA University.

Forest fires (wildfires) have been selected as a tangible problem to deal with during the theoretical and empirical sessions of the course. The wildfire phenomena is targeted as a phenomena emerging at landscape scale but with a clear interference with the human settlements. The research process was guided by a semi-structured workflow, which was revised through group discussions among participants.

Each class session was aimed as workshop more than a lecture. The students were invited as workshop participants into the process not as ‘classical’ listening students. Yet, it is very crucial to learn about and understand the professional background of each student in order to well define the goals and expectations of the research work. This is crucial for delivering relevant tasks during the research process.

Working in teams of 4 members resulted successful and a fair workload distribution. As well as, working on different but equivalent study areas enabled coordinated and comparative discussions during the evaluation sessions. QGIS software resulted a useful tool for a cost free and dynamic research process to enable not only geospatial analysis but also qualitative graphical results.

RBL resulted to be an effective teaching method which invites the student as a responsible professional into the learning process. Thus, it goes beyond knowledge gaining and enhances the skills of the student to perform a semi-independent research work. The applied method is appropriate for courses delivered in graduate level studies.

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