

Experiences of a Brazilian-Hungarian Erasmus Collaboration on Cartography and GIS

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Abstract: Current work intends to offer an abbreviated view of the partnership in the areas of Cartography and GIS between Eötvös Loránd University (Budapest, Hungary) and Federal Fluminense University (Niterói, Brazil) within the Erasmus+ ICM Program. The first contacts between both institutions are briefly reviewed, which started in the Commission on Cartography and Children of the International Cartographic Association at the end of the 20th century and expanded and strengthened over the years with different joint activities before the first Erasmus project in 2019. The Erasmus projects gave us the opportunity to organize a more systematic teaching exchange, which was preceded by contacts to determine the subjects to be taught to the students of our degrees. In this paper we describe in more detail the structure and content of two of the courses offered during our exchange and give an insight into the experiences gained by our students, how the courses have contributed to broaden and diversify the knowledge they can make use of during the completion of their theses and in general in their future professional work.

Keywords: Erasmus, cartography, GIS, geovisualization, education

1. Introduction to degrees related to Cartography and GIS in both institutions

1.1 Eötvös Loránd University (ELTE)

The Department of Cartography was founded in 1953 and two years later the first third-year students with the major of geography or geology could start their cartography studies. In accordance with the general education reform introduced beginning the decade of the 70-s the master's degree in Cartography was three-year-long, and students were coming from a four-semester-long Earth Sciences bachelor degree including future students of MSc degrees on Geology, Geophysics, Meteorology, Astronomy and Cartography.

After the implementation of the Hungarian education law in 1986 a new, ten-semester-long Cartography MSc degree was introduced, which started in the academic year of 1988-1989. The next significant change was in 2006, when the reforms inspired by the Bologna process were introduced in Hungary: students arrived at the four-semester-long Cartography MSc degree after finishing the six-semester-long bachelor's degree in Earth Sciences. A MSc degree in Geoinformatics was also introduced in 2022. The Cartography MSc and the Geoinformatics MSc in English language started in 2016 and 2024 respectively.

Until recently more than 500 students have obtained a Cartography diploma at Eötvös Loránd University. The PhD program related to Earth Sciences started in 1994, and by 2024 almost 50 students obtained this degree. In 2024 a PhD degree on Geoinformatics was included in the

Doctoral School of Informatics. The department became the Institute of Cartography and Geoinformatics in 2020.

1.2 Federal Fluminense University (UFF)

The Federal Fluminense University is a relatively young institution, having been founded on December 18, 1960. Different academic units are part of the university, one of them is the Institute of Geosciences, which houses the Department of Geoenvironmental Analysis (previously called Department of Cartography). This department is responsible for the subjects of Cartography, Geoprocessing, Remote Sensing, Positioning and Navigation and Topography, among others in the environmental area. Despite its name (Department of Cartography), in the early years it operated in two basic areas, Engineering (Topography courses) and Geography (Cartography courses). It should be noted that map production techniques were combined with the interpretation of geoenvironmental data; the department's interest was increasingly directed towards geospatial analysis of the environment in addition to its representation itself. In the 1980s, this trend was accentuated with the introduction, as a pioneering initiative in Brazil, of disciplines specifically focused on remote sensing and geoprocessing.

Recently, the department has been discussing the creation of a postgraduate program focusing on Geospatial Technology, since some of its professors had been developing research on this topic, contributing to the creation of a significant bibliographic collection in this area. Already in progress for 25 years, the Postgraduate Program in Geography, in the Institute of Geosciences has

trained hundreds of students in the Territorial Planning area, also using cartography and geotechnologies in spatial analyses.

2. Antecedents of current collaboration

Both institutions have had contacts in international events and within the International Cartographic Association (ICA), more exactly within the ICA Commission on Cartography and Children beginning from 1999. Prof. Reyes visited the UFF and gave presentations for the students and professors in November 2011. On this occasion, representatives from the UFF Institute of Geosciences informed him about a new, emerging initiative: the organization of a national competition for elementary and secondary schools, which is related to school cartography and to be named Brazilian Cartography Olympiad (OBRAC). The first Olympiad was organized in 2015, coinciding with the organization in Rio de Janeiro of the International Cartographic Conference (ICC 2015) and the Institute of Geosciences also organized a three-day pre-conference workshop with the participation of four ICA commissions, led by the Commission on Cartography and Children. The final of the first Cartography Olympiad was timed to coincide with the start of the workshop and counted with the personal participation of prof. Jesús Reyes, as well as the official announcement of the results and awards ceremony took place during the conference. From then on, prof. Reyes collaborated assiduously with the Brazilian Olympiad as a member of the OBRAC Jury.

Since then, both institutions have exchanged many plans for our collaboration, which led to the realization of our first Erasmus ICM project from 2018 to 2020 and was followed by a second one from 2023 to 2025.

3. Brief description of the Erasmus projects

In May 2019, Prof. Angelica Di Maio taught a course at ELTE in the framework of the first project. The course was given in the Institute of Cartography and Geoinformatics (Faculty of Informatics, ELTE), based on the experiences on school cartography at UFF. The course covered the following topics: the field of school cartography (scenarios and applications); school cartography and educational projects (geoinformation for citizenship education); some current school cartography projects; planning and making of school cartography projects; as well as graphic semiology as a support for thematic cartography representation in school cartography. In the same year, prof. Krisztina Irás and prof. Jesús Reyes visited Niterói and Rio de Janeiro and taught the following courses: *Data driven Cartography* (at UFF) and *Cartography and Geovisualization* (at UFRJ). The *Data driven Cartography* course offered in 2019 at UFF included four main themes: methods of cartographic data visualization, characteristics and modern technologies of thematic map making in sciences and in school cartography, creating thematic map series using GIS solutions, as well as practical solutions for printing and online publishing.

Unfortunately, the course planned by Prof. Jesús Reyes for UFF students in 2020 could not be taught due to the COVID-19 pandemic. Our cooperation continued in March 2024 with a new Erasmus+ ICM project for the period 2023-2025. Prof. Jesús Reyes offered the course entitled *Cartography and Geovisualization* and participated in academic discussions at UFF. In May 2024 Prof. Angelica Di Maio offered the *Cartography, Education and Citizenship* course at ELTE. This course promoted a discussion of the role of geospatial knowledge in understanding the complexity of the organization of society and its relations, considering that geoinformation provides means to think spatially and the knowledge of space is fundamental to the exercise of citizen's rights. During the course students had the opportunity to discuss the important role that is played by cartography in educational projects (Figure 1).



Figure 1. Photos taken during the courses given in Niterói (above) and Budapest (below) in 2024

3.1. Structure and content of the course on Cartography and Geovisualization

The course was planned to have 16 hours of teaching activities, combining theoretical presentations and practices. It was developed in the Institute of Cartography and Geoinformatics at Eötvös Loránd University for the students at the Federal Fluminense University. The determination of topics and detailed content addressing fields like cartography, geovisualization and web-based applications constitutes a real challenge for the educators. Two premises had to be filled: finding a balance in the presentation of themes related to geovisualization and thematic cartography (theoretical themes), as well as deciding which of the latest map-based solutions for geovisualization can be presented and which practical examples can be selected and explained in a relatively short period of time (practical classes).

This course was based on the “Geovisualization-based solutions in cartography” subject, which is given in English for international students of the MSc degree on Cartography in the Institute of Cartography and Geoinformatics at Eötvös Loránd University. The course was presented in Portuguese for the Brazilian students. It was not only a selection of themes, and a resume of the content included in that subject, but at the same time it was updated with the latest theoretical and practical knowledge, including some of the newest solutions for online data visualization and map making.

The content of the course was as follows:

Theoretical themes:

- **Introduction: Brief history of geovisualization (data visualization and thematic cartography)** - The main aim of the introduction was to give a general background about the development of data visualization in general and specifically of map-based visualization beginning from 950 A.C. to nowadays. The history of the more general data visualization was also included within this topic, because the graphic solutions applied for data visualization were later (or simultaneously) adapted for their use on maps too. For this reason, data visualization can be considered the previous stage for the cartographic representation of data. Some examples of the specific topics presented in this part: John Graunt as the author of the first systematized statistical data collection published as a book (*Natural and Political observations mentioned in a following index, and made upon the Bills of Mortality*, 1662), Edmund Halley's maps (1686-1701), charts created by William Playfair (18th century), maps of Valentin Seaman (1798) and John Snow (1855), Humboldt's works (19th century), Berghaus atlas (19th century), Charles Minard's chart of Napoleon's Russian campaign of 1812 and other previous works, Otto Neurath and his Isotype method for the iconographic representation of data, Jacques Bertin's Graphic Semiology, the first computer-based maps as well as GIS- and online cartography.
- **Geovisualization without computers: a Hungarian-American-Cuban example from the 20th century** - Theme dedicated to Erwin Raisz, the Hungarian-born cartographer who became internationally famous when he taught in the United States. He worked at Columbia University, Harvard University and the University of Florida, working on subjects such

as the physiographic representation of relief and the use of cartograms. He also maintained a close relationship with Cuban geography and collaborated with Cuban specialists in the publication of textbooks and the making of maps for education. In 1949, Raisz and a Cuban geographer, Gerardo Canet, published the atlas that can be considered an example of traditional (printed) geovisualization: the Atlas of Cuba.

- **Thematic Cartography in the German and Hungarian Cartographic School** - In this topic was given a brief history of the term *Thematic Cartography* and previous names used to identify this specific field within cartography. It was followed by an introduction to the main cartographic schools, presenting their most important personalities and their works, trying to resume the main characteristics of each school. A more detailed introduction to the German school was also given, which had a special influence in the development of Hungarian thematic cartography. It was followed by the classification of maps and methods of representation, as well as practical examples about the correct and incorrect use of thematic maps.
- **Alternative methods of representation in the current cartography (1st part): cartograms or anamorphic maps** - This theme was dedicated to a method of representation that constitutes a matter of discussion within the international cartographic community: the use of cartograms. A brief introduction was given with the history of this method and the better-known specialists, who developed research on this topic (e.g. Erwin Raisz, Waldo Tobler, Daniel Dorling). It was followed by the definitions, differences between the names of the method in different languages, as well as its classification and a discussion on its advantages and disadvantages. Different examples of cartograms and international research projects related to this topic were also presented (Reyes 2014).
- **Alternative methods of representation in the current cartography (2nd part): Chernoff faces and its use in cartography** - Chernoff faces are a purely statistical method, originally not created to be used on maps. It was adapted for cartography in the second half of the 70s, but its use was not always correctly based on cartographic and graphic principles. The professor presented the original method created by Chernoff and its use in Statistics, as well as

showed the first maps made using this method. Special emphasis was placed on presenting the proposals for the use of this method in School Cartography, which is based on the results of international research. A special topic was the adaptation of the Chernoff principle for its use with pictograms, including different examples. Finally, the results obtained during school surveys organized in two international research projects were also presented (Reyes 2010).

- **Current solutions for the geovisualization of data: examples and international projects** - A presentation annually updated because of the fast and dynamic development of this field on the web. Different examples downloaded from the web were used to explain solutions developed during the last years for the map-based visualization of data or to complete geovisualization with other graphic solutions. Furthermore, graphic solutions less used in cartography were also introduced for the students, e.g. the possible use of tag clouds, more specifically of data clouds using a map. Special emphasis was placed on the presentation of examples related to the thematic 3D models, e.g. noise mapping. Finally, some international research projects developed on this theme were also presented.

Practical themes (examples of practical online solutions for geovisualization and map making):

- **Using the WordArt website to create word- and data clouds** - Tag clouds are a graphic solution that has become very popular on the web in the last years. It was not originally created to be used on maps, but one of its variants gives us the option of creating a cloud using not only text, but also data. This variant was discussed in the classroom and the students had the opportunity to create word- and data clouds using contour maps on the WordArt website.
- **Using the go-cart online application to make cartograms** - Students learned how to create an area cartogram on the go.cart website. Currently it is one of the most popular types of cartograms, which was developed by Michael T. Gastner, Associate Professor of Information and Communication Technology at the Singapore Institute of Technology and co-author of the Diffusion-based method for producing density-equalizing maps together with M. E. J. Newman,

from the Department of Physics at the University of Michigan (Gastner 2024).

- **Creating thematic maps and diagrams with the Datawrapper online application** - Students learned how to work using the graphic options offered on the Datawrapper website, which was created by Gregor Aisch, visual data journalist at Zeit Online. Students created different types of charts (diagrams) as well as thematic maps using choropleths and proportional symbols.
- **Brief presentation of the options in ArcGIS Online and ArcGIS StoryMaps to create thematic maps and story maps** - Students had the opportunity to learn at a basic level how to create thematic maps using the ArcGIS Online Map Viewer, as well as how to make a story map to present their research results online using dynamic and animated tools.

3.2. Structure and content of the course on Cartography, Education and Citizenship

The 15-hour course was developed in the Institute of Geosciences at the Federal Fluminense University and offered in English for Hungarian and foreign students in the master's degree on Cartography at Eötvös Loránd University in Budapest. The topics covered in the course were:

- **Cartography education in the information era** - Maps are powerful tools for understanding the complexity of modern society. Cartography can help understanding the spatial distribution of phenomena and it is a very significant opportunity for students, since spatial thinking helps to find solutions for some everyday problems, especially the ones related to spatial organization. The new technological tools, such as geotechnologies and web maps have made great contributions to the increasing accessibility of graphic representations.
- **Cartography and educational projects: geoinformation for citizenship education**

Cartography, as a scientific method of research, processes facts and phenomena related to different areas of knowledge. Map making has a social and political responsibility as they spatialize physical and human issues and relationships present in society.

On this topic, some projects that made relevant contributions to cartographic education were

shown, for example, the Brazilian Cartography Olympiad (OBRAC). This educational project has national coverage and is focused on high school students, aged between 13 and 19 years. The main objectives of OBRAC are to disseminate Cartography as science and awaken in students the curiosity and interest in Cartography and the use of technological tools focused on spatial knowledge for citizenship, through challenging activities that stimulate learning and autonomy of the student (Di Maio et al. 2015).

It was taught how Cartography, when used in the creation of varied multimedia materials on education and citizenship, fulfills an integrative role in the school, because it promotes the multi- and interdisciplinary participation in teams.

The works submitted to the 5th edition of OBRAC in 2023 were also presented within this topic (Di Maio et al., 2024). The 5th edition of OBRAC proposed innovative activities related to the mapping of natural resources and indigenous peoples in the Amazon, using geotechnology. Brazilian students participated in the Olympiad mapping different themes related to the potential of the Amazon region. They worked in teams and made participatory and collaborative maps on topics such as cultural values and aspects related to the traditional people of the region; presence of natural resources or traditional activities, such as traditional fishing, environmental services; as well as biodiversity: flora and fauna. They used the OpenStreetMap OSM platform for mapping Amazonian features and represent the challenges found in the region.

- **Cartography and spatial thinking: scenarios and applications** - In this topic students discussed the important role of cartography and geotechnologies to the exercise of citizen's rights. They used GIS software and also other geotechnologies such as GNSS (Global Navigation Satellite System), as well as analyzed remote sensing images as powerful tools in school activities that can encourage learning and mobilizing citizenship actions.

4. Results obtained during the projects

After the courses were completed, professors asked students to select topics of interest to them (e.g. research topics they were developing or themes related to their theses). The submissions were evaluated and thanks to the interest and dedication shown by the students, the results were very positive (Figure 2). The final projects showed coherence with the aims proposed during the organization

of the courses and demonstrated the good preparation of the participants, even in the very limited time available to carry out the activities. According to the submitted works, it may be noted the diversity of alternatives used by the students to solve multidisciplinary questions involving map-based geovisualization techniques and methodologies related to thematic cartography.

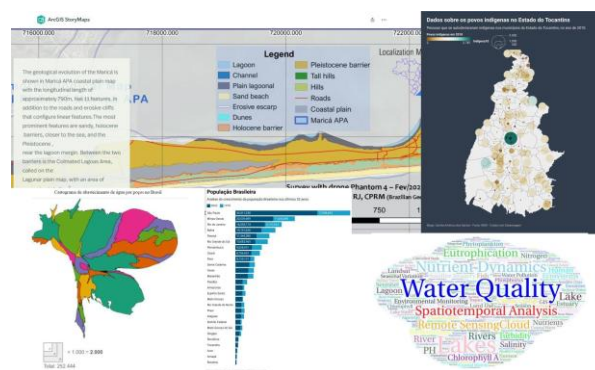


Figure 2. Works developed by the students using the tools taught during the courses

In addition to these very specific results, we consider that our cooperation contributed to expanding and reinforcing the students' interest in the art and science of maps. Being able to offer students the most up-to-date knowledge (e.g. based on the latest results presented at international events) and practices (e.g. advanced applications for geospatial representation) requires a considerable effort to improve the more traditional and older solutions used in the teaching and learning of cartography. Collaborations such as this one are an irreplaceable source of useful experiences that are adaptable to the needs of students in different countries.

Colleagues who participated in the project are also interested in sharing their experiences both nationally and internationally, so work is underway to present posters and papers such as this current one.

Students have also been motivated to use the acquired knowledge beyond their usual tasks. A good example is the scientific article written by Camila Américo dos Santos, one of the students who participated in the Cartography and Geovisualization course at UFF in 2024. She wrote an article in Portuguese entitled "A Contribuição das Mídias Sociais para o Mapeamento de Desastres: Uma Revisão Bibliométrica Baseada em Proknow-C" (The Contribution of Social Media to Disaster Mapping: A Bibliometric Review Based on Proknow-C), in which she used different graphical solutions to visualise the results of her research (Américo et al. 2024).

Another result that can be considered derived from this collaboration is the planned master's degree in Geospatial Technologies, a postgraduate program proposed by the Institute of Geosciences at UFF, which counts with the participation of Prof. Jesús Reyes. In December 2024 the proposal was in the approval phase.

At the same time, we follow the cooperation in the Brazilian Cartography Olympiad project (OBRAC), which will complete 10 years in 2025 (Di Maio & Veiga 2015), as well as in the Barbara Petchenik Children's Map Competition, which is organized by the ICA Commission on Cartography and Children.

5. Future plans

The cooperation is important for both institutions because it can generate new ideas as important contributions to our research in the field of geospatial information. It is also outstanding to plan differentiated pedagogical activities such as the Brazilian Cartography Olympiad, or innovative solutions for school cartography and not forgetting its contribution to the planning of the new MSc degree on Geospatial Technologies.

It is intended that the graduate and undergraduate courses offered in Brazil (UFF and UFRJ) by the professors from ELTE and courses offered by UFF and UFRJ professors at ELTE, especially in the field of Cartography and Geotechnologies, will continue in the next few years. It is also expected that mobility programs can increase the partnership adding also students' participation.

The collaboration intends to follow making contributions for expanding the use of cartography in schools and engaging students and teachers in the development of activities for the promotion and enrichment of geospatial knowledge in the school community. The exchanges of experiences encourage professors and students in using new technologies and in particular new geospatial tools, in the benefit of understanding the mutual relation and influence between geographic space and society as well.

b) The Erasmus program has been promoting the opportunities to offer courses to students from different countries and cultures. Our participation in the program also contributes to sharing experiences and knowledge, as well as to developing collaborative work, which at the same time helps the institutions to amplify international collaboration.

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