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ANALYSIS OF RIVERS ON THE MAP, IN PRIMARY EDUCATION

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ABSTRACT

The purpose of this study is to identify the effects of individual use of a worksheet in analyzing the network of flowing waters in a territory represented on a map and partially known by the students. 16 fourth grade students participated in the study. In the activity, three stages were completed: in the first stage, the students solved a pre-test with 10 True-False items about the flowing waters of the studied territory; in the second stage they solved the tasks in a worksheet based on the analysis of flowing waters represented on the map; in the third stage the students solved a post-test similar to the one in the first stage. The results show that the students, after analyzing the map with the help of the worksheet, in the formative intervention, have a greater volume of knowledge about the running waters of the commune where they live, which proves the effectiveness of this worksheet

Keywords: *worksheet, watershed, rivers, analysis, simultaneous learning, individual activity*

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INTRODUCTION

The first knowledge about water, including flowing waters, is acquired by children during formal learning activities organized in preschool education, within the “science” field (Dulamă, 2012). Knowledge about flowing waters is further expanded in primary education, where it is studied in preparatory class, first grade, and second grade under the subject "Mathematics and Environmental Exploration" (Buda et al., 2020; Dulamă, 2010; Pahome, 2023a), and in fourth grade in the subject "Geography" (Dulamă, 2011; Tălângă, 2007). Students gain knowledge about flowing waters in the "Mathematics and Environmental Exploration" subject in the preparatory class [CP] when they study the topic "The Presence of Water in Nature in Various Forms (precipitation, rivers, lakes, sea, etc.)," included in the "Earth Sciences" field. They deepen their knowledge about hydrographic networks in the second grade within the topic "Intuitive Elements Related to Planet Earth", studying aspects of "Composition: land, water, and atmosphere" (Ministry of National Education, 2013, p. 25).

Students further deepen information about flowing waters from a systemic perspective in the subject "Geography" in the fourth grade, within the field "Elements of Geography of the Local and Nearby Horizon," under the topics "Observable General Characteristics of the Local Horizon: Relief, Hydrography, Vegetation" and "From the Local Horizon to the Country: Hometown" (Ministry of National Education, 2014, p. 8). The study of flowing waters is extended by students from the level of their hometowns (Dulamă, 2010c; Mândruț et al., 2012; Mihus, 2015) to the entire planet in the fifth grade in the subject "Geography" (Dulamă, 2007, 2010e) and is further deepened by

analyzing hydrographic units from different countries and continents (Ilovan & Dulamă, 2010; Ilovan et al., 2010).

In the geographical literature, it is noted that flowing waters have been studied from multiple perspectives, demonstrating the importance attributed to understanding these issues by researchers. A series of studies have focused on analyzing water resources (Hârlav, 2023a; Farkas et al., 2010), the potential of average liquid runoff (Sorocovschi & Horváth, 2007), multi-annual average runoff (Pop & Horváth, 2009), seasonal and monthly runoff regimes (Conțiu, 2006), the water balance (Sorocovschi et al., 2009; Sorocovschi et al., 2018), and seasonal flow regimes (Sorocovschi et al., 2014; Sorocovschi et al., 2015).

In Romania, a topic of interest for researchers is the high flow rates of rivers and their effects, leading to analyses of flood zones (Bilașco & Horváth, 2016; Șerban et al., 2009), characteristics of high flow periods for certain rivers (Hârlav & Sorocovschi, 2020), floods that have affected specific cities (Conțiu & Conțiu, 2007a), natural hazards generated by flowing waters (Roșian et al., 2021), the influence of relief on river water flow (Hârlav, 2023b), the impact of hydrotechnical installations on river water flow (Șerban, 2004), dysfunctions (Popa et al., 2017) and the impact of changes in forested areas on waters (Sidău et al., 2021), the relationship between rivers and other environmental components (Rus et al., 2019, 2020), and the vulnerability of settlements in cases of torrential flows (Hattemer, 2009). Considering that many Romanian residents face the effects of floods, some researchers have investigated their perceptions of flood-induced risks (Conțiu & Conțiu, 2005, 2007b, 2017). Some studies have focused on riverbed dynamics (Pandi & Horváth, 2012), river management in urban areas (Ilovan et al., 2020), and developing the competency to create river basin management plans (Dulamă et al., 2016).

In Romanian primary education, studies have been conducted on geographic content related to: the use of films in education generally (Ilie et al., 2021); studying rural settlements (Ilie et al., 2020); using animated films in learning (Vereș & Magdaș, 2020) and in observing natural phenomena (Vereș et al., 2020); exploring a stream (Dulamă & Buda, 2014); observing nature (Pahome, 2022a, b; Pahome, 2023a, b, c); and harnessing water as an energy source (Buda et al., 2020). Some researchers have focused on the competencies and content included in the school curriculum for "Mathematics and Environmental Exploration" (Dulamă & Magdaș, 2014), the initial training of teachers for teaching "Mathematics and Environmental Exploration" (Magdaș et al., 2018), teachers' perceptions of digital textbooks for "Mathematics and Environmental Exploration" (Magdaș et al., 2017a), official documents (Magdaș et al., 2017b), and outdoor activities (Deac et al., 2019). Some studies have investigated teachers' opinions on interactive activities in digital textbooks (Buzilă et al., 2017; Ilovan et al., 2018), the use of digital applications in instruction (Magdaș et al., 2019a), and the use of smart boards in e-learning for "Mathematics and Environmental Exploration" (Magdaș et al., 2019a).

From the analysis of literature in Romania and studies conducted worldwide on water, it is observed that researchers have shown limited interest in studying flowing waters among primary school students; this topic is often integrated secondarily within research that addresses broader subjects. Based on the analysis of these studies and the recognized need for students to be supported by teachers in systematically studying flowing waters, we initiated research aimed at identifying the effects of using an individual worksheet to analyze the network of flowing waters in a territory represented on a map.

In this context, the independent variable of our study is as follows: the observation and analysis of flowing waters on the map of a territorial-administrative unit, guided by a worksheet prepared by the teacher. The dependent variable is the volume of information about flowing waters acquired by students as a result of analyzing the map of flowing waters in a territorial-administrative unit. In the study, the following research hypothesis was tested: the volume of information about flowing waters acquired by students through analyzing the map of flowing waters in a territorial-

administrative unit, indirectly guided by the teacher via a worksheet, increased as a result of this learning activity.

METHODOLOGY

***Participants*.** The study was conducted during the 2024-2025 school year in two schools located within the territorial-administrative unit Măguri-Răcătău: the Măguri-Răcătău Middle School and the Măguri-Bogdănești Middle School. Fourth-grade classes from the two schools were selected based on several criteria: alignment with the geography curriculum for fourth grade and the possibility of using thematic maps. The student participants were selected based on their enrollment in one of these two schools and in a fourth-grade class. A total of 16 fourth-grade students participated in the research. The fourth-grade students from Măguri-Bogdănești study in multi-grade classrooms. The students are 11-12 years old. They were informed about the research objectives, the conditions under which the activity would take place, and the requirements they were expected to follow. The students voluntarily agreed to participate in the pre-test, learning activity, and post-test, without receiving grades or rewards. Confidentiality of students' personal data was maintained, and the provisions of the "General Data Protection Regulation" were adhered to. The primary school teachers from the two classes, who organized the teaching activities, were involved in the research.

***Procedure*.** The activity took place during a geography lesson in each of the three classes. In the first stage, students completed the pre-test items; in the second stage, the individual learning activity was organized in each class; and in the third stage, students completed the post-test items.

***Educational Activity*.** After completing the pre-test items, students were instructed to individually observe the "Map of Flowing Waters in the Territorial-Administrative Unit of Măguri-Răcătău" (Figure 1) and fill out their "Worksheet" (Table 1). Students were given 25 minutes to complete their responses. After analyzing the map and completing the worksheet, the teacher discussed with the students how they addressed the assigned tasks.

Table 1
Themes, objectives and tasks in the "Worksheet"

Themes	Objectives	Tasks in the "Worksheet"
1. General characteristics of the hydrographic network in the commune	1.1. Identification of the main rivers in the commune	1. Look at the map and fill in the blanks. The main river in the western part of the commune is …. The main river in the central part of the commune is …. The main river in the eastern part of the commune is ….
	1.2. Identification of the main river type according to the source	2. Look at the map and cross out the wrong or inappropriate words. The Răcătău River has/does not have its source on the territory of the commune, so it is autochthonous/non-local. The Someșul Rece River has/does not have its source on the territory of the commune, so it is autochthonous/non-local. The Râșca River has/does not have its source on the territory of the commune, so it is autochthonous/non-local.
	1.3. Identification of the flow direction of the main rivers	3. Look at the map and fill in the blanks. The Răcătău River flows from ... to ... The Someșul Rece River flows from ... to ... Râșca River, after the confluence between Râșca Mare and Râșca Mică, has the direction of flow from ... to ...

2. Characteristics of the main running waters	2.1. Identification of component parts and their characteristics	4. Look at the map and cross out the wrong or inappropriate words. The component parts of a river are: source, watershed, river course, mouth. If the statement is correct, circle the word True, if it is wrong, circle the word False. The Răcătău River has a winding route. True/False The Someșul Rece River has a winding route. True/False The Râșca River has a winding route. True/False Fill in the blank. The Răcătău River flows into the river ....
	2.2. Identification of tributaries and their characteristics	5. Look at the map and cross out the wrong or inappropriate words. The Răcătău River has the most tributaries on the left/right side The Someșul Rece River has the most tributaries on the left/right side. The Someșul Rece River has the longest left/right tributaries. Fill in the blank. The longest tributary of the Răcătău river is...

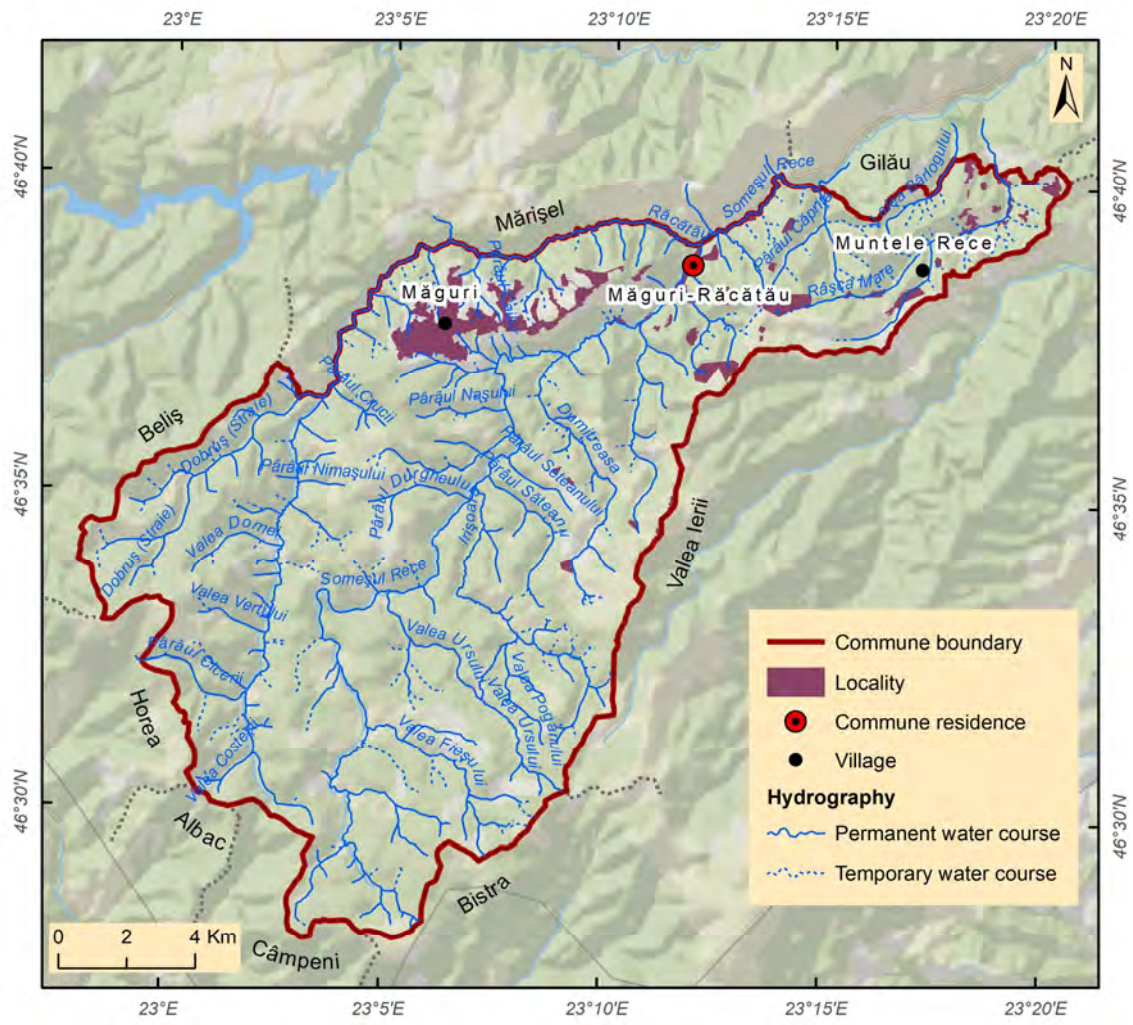
Instruments. The research data were collected through a pre-test and a post-test. Each data collection instrument includes 10 dual-choice items of the True/False type. The maximum score assigned for correctly completing a test is 10 points. The two tests contain similar items, designed by the authors based on the content of the map used during the formative intervention stages and the objectives intended to be achieved by the students. Scores on the pre-test and post-test were calculated for each participating student. To check for differences between the students' results obtained in the first and third stages, the group's average score on each test was calculated, and the results were compared.

Table 2

The tools used to collect research data

Pre-test	Post-test
1. The locality of Măguri-Răcătău is crossed by the Someșul Rece River. 2. The locality of Măguri is crossed by the Răcătău River. 3. The locality of Muntele Rece is crossed by the Râșca Mică River. 4. The Răcătău River is the longest flowing water in the commune. 5. The Someșul Rece River has tributaries that collect water from the Gilău Mountains and Muntele Mare. 6. The Someșul Rece River has the most tributaries in the Gilău Mountains. 7.The Răcătău River flows from south to north 8. The Someșul Rece River flows from north to south. 9. The Răcătău River flows into the Someșul Rece River. 10. The Someșul Rece River collects water from a smaller area in the commune of Măguri-Răcătău than the Răcătău River.	1. The locality of Măguri-Răcătău is crossed by the Răcătău River. 2. The locality of Măguri is crossed by the Someșul Rece River. 3. The locality of Muntele Rece is crossed by the Râșca Mare River. 4. The Someșul Rece River is the longest flowing water in the commune. 5. The Răcătău River has tributaries that collect water from the Gilău Mountains and Muntele Mare. 6. The Someșul Rece River has the most tributaries from Muntele Mare. 7. The Răcătău River flows from north to south. 8. The Someșul Rece River flows from south to north. 9. The Someșul Rece River flows into the Răcătău River. 10. The Someșul Rece River collects water from a larger area in the commune of Măguri-Răcătău than the Răcătău River.

Figure 1
Map of flowing waters in Măguri-Răcătău commune



RESULTS

In the tests, the students obtained the results included in Table 3. In the pre-test, most students obtained scores of 6 (7 students; 43.75%) and 7 (6 students; 37.50%). Students obtained lower scores on items 4, 5 and 8 (Table 4), which indicates gaps in the knowledge of the length of the main rivers in the commune and their flow direction, watersheds and tributaries.

After analyzing the map and solving the tasks in the worksheet, in the post-test, most students obtained scores of 9 (9 students; 56.25%), 5 students obtained scores of 10 (31.25%). The results show that the students solved better the items they had difficulties with in the pre-test, with the exception of one item that refers to the origin of the tributaries of the Răcătău River. Regarding the mean, a large difference is found between the pre-test (M = 6.81) and the post-test (M = 9.18), which indicates the increase in the volume of knowledge and the confirmation of the research hypothesis.

Table 3
Students' pre-test and post-test scores and averages

Scores	Pre-test		Post-test	
	Nr.	%	Nr.	%
6	7	43.75	-	-
7	6	37,50	-	-
8	2	12.50	2	12.50
9	1	6.25	9	56.25
10	-	-	5	31.25
Media	**6.81**		**9.18**	

Table 4.
Student scores on pre-test and post-test items

Pre-test	Correct	Post-test	Correct
1.The locality of Măguri-Răcătău is crossed by the Someșul Rece River.	15	1.The locality of Măguri-Răcătău is crossed by the Răcătău River.	15
2.The locality of Măguri is crossed by the Răcătău River.	14	2.The locality of Măguri is crossed by the Someșul Rece River.	16
3.The locality of Muntele Rece is crossed by the Râșca Mică River.	10	3.The locality of Muntele Rece is crossed by the Râșca Mare River.	16
4.The Răcătău River is the longest flowing water in the commune.	3	4.The Someșul Rece River is the longest flowing water in the commune.	16
5.The Someșul Rece River has tributaries that collect water from the Gilău Mountains and Muntele Mare.	9	5.The Răcătău River has tributaries that collect water from the Gilău Mountains and Muntele Mare.	5
6.The Someșul Rece River has the most tributaries in the Gilău Mountains.	12	6.The Someșul Rece River has the most tributaries from Muntele Mare.	16
7.The Răcătău River flows from south to north.	10	7.The Răcătău River flows from north to south.	15
8.The Someșul Rece River flows from north to south.	7	8.The Someșul Rece River flows from south to north.	15
9.The Răcătău River flows into the Someșul Rece River.	13	9.The Someșul Rece River flows into the Răcătău River.	14
10.The Someșul Rece River collects water from a smaller area in the commune of Măguri-Răcătău than the Răcătău River.	13	10.The Someșul Rece River collects water from a larger area in the commune of Măguri-Răcătău than the Răcătău River.	16

DISCUSSIONS AND CONCLUSIONS

The activity carried out with the students primarily contributed to the development of the general competence outlined in the school curriculum for the subject "Geography": "1. Presenting the observable reality, using general and specific terminology" (Ministry of National Education, 2014, p. 4). Even though the students, through solving the tests and tasks, do not present in an oral or written text the reality represented on the map, they develop two specific competencies derived from the first general competence mentioned earlier: "1.1. Identifying geographic terms in different texts/context situations/learning situations" and "1.3. Using simple geographic terms in familiar contexts" (Ministry of National Education, 2014, p. 5).

To solve the items in the tests and tasks from the worksheet, the students should know several concepts or "geographic terms": flowing water, river, spring, river course, mouth, tributary,

confluence, and watershed. If the students do not know some of these terms, they may leave the task unsolved, solve the task randomly and incorrectly, or ask the teacher for support when using the worksheet to clarify the unknown terms. In combined classes, it is more difficult for students to request additional information from the teacher during the individual activity because the teacher pays more attention to the students from the other class and should not interrupt the activity. In this context, the possibilities for the teacher to monitor the individual work of the students and how they solve the tasks in the worksheet are reduced. To prevent students from being unable to solve the tasks, the teacher can provide a text with definitions and other necessary information, which fulfills the feedforward function (Dulamă & Ilovan, 2016).

By involving students in this activity, they develop the general competence outlined in the school curriculum for the subject "Geography": "3. Relating the surrounding reality to its cartographic representation," and four specific competencies: "3.1. Identifying the position of elements represented on the map"; "3.2. Using symbols and other conventional representations"; "3.3. Correctly reporting the position of elements on cartographic representations"; "3.4. Using simple graphic and cartographic representations" (Ministry of National Education, 2014, p. 4). Students make the connection between the symbol of flowing waters on the map legend and the representation of the rivers' and their tributaries' paths on the map, identifying their position in the area, the direction of flow, and the orientation of the watercourses based on the cardinal points.

To facilitate the discovery of information or correct solutions, most tasks in the worksheets offer two options (True/False; two constructed answers) from which the students should deduce the correct one. The worksheet acts as an indirect guide from the teacher (Pahome, 2023b) and was designed as a tool with a feedforward function (Dulamă & Ilovan, 2016). The proposed activity is challenging because the students have not previously analyzed such a map on their own, but the challenging task places the students in the zone of proximal development (Vygotsky, 1962).

The development in fourth grade of the general and specific competencies in geography is based on the competencies formed in the previous classes in the subject "Mathematics and Environmental Exploration." By studying flowing waters in the first three years of primary education, students begin to form the general competence "2. Highlighting the geometric characteristics of objects located in the surrounding space" (Ministry of National Education, 2013, p. 3). In grade CP (preparatory grade), the curriculum specifies that students should form the specific competence "2.1. Orienting and moving in space in relation to specified landmarks/directions, using phrases such as: in, on, above, below, next to, in front of, behind, up, down, left, right, horizontal, vertical, oblique," and in grade I, the specific competence "2.1. Orienting and moving in space in relation to given landmarks/directions, using phrases such as: in, on, above, below, next to, in front of, behind, left, right, horizontal, vertical, oblique, inside, outside" (Ministry of National Education, 2013, p. 9). Regarding the analysis of the tributaries of flowing waters, students discover which are the right and left tributaries of the rivers, provided the teacher indicates that this characteristic of the tributaries is determined by looking towards the direction of flow of the river, downstream, towards the mouth.

In the analysis of flowing waters, students use knowledge related to the specific competence outlined for development in the second grade: "2.1. Locating objects by establishing coordinates relative to a given reference system, using the learned phrases" (Ministry of National Education, 2013, p. 9). In this case, students determine the position of flowing waters based on the coordinate system, cardinal points, and intercardinal points.

To solve the tasks in the worksheet, students need the knowledge integrated into the general competence "3. Identifying phenomena/relationships/regularities/structures from the nearby environment," developed in the first three grades in the subject "Mathematics and Environmental Exploration" (Ministry of National Education, 2013, p. 3), and those integrated into three specific competencies: "3.1. Describing simple repetitive phenomena/processes/structures from the nearby environment to identify regularities," developed in the first grade; the specific

competence "3.1. Solving problems by observing regularities from the nearby environment," developed in the first grade; and the specific competence "3.1. Solving problems in investigations by observing and generalizing models or regularities from the nearby environment," developed in the second grade (Ministry of National Education, 2013, p. 11). Regarding flowing waters, students should know from the first three grades that flowing waters move regularly towards areas and points with lower altitudes; there is a collector river that collects waters from a certain area through its smaller tributaries (in terms of length, flow, level); and flowing waters move in opposite directions from the watershed divide. Students should observe the hydrographic basins as models of organizing the flowing waters within a territorial unit.

In analyzing the flowing waters represented on the map, students use knowledge integrated into the general competence "5. Solving problems by sorting and representing data" (Ministry of National Education, 2013, p. 3), and the specific competence "5.1. Sorting/classifying objects/materials based on a given criterion," developed in the first grade, and the specific competence "5.1. Sorting and classifying data from the nearby environment based on two criteria," developed in the first grade (Ministry of National Education, 2013, p. 16). Students sort and classify flowing waters represented on the map based on visible features: length, direction of flow, and sinuosity of the course.

From the geographical perspective, through the analysis of flowing waters in a territorial unit in this learning activity, students began developing the competence to analyze a fluvial hydrographic system (Dulamă, 2010b) and continue developing their competence to analyze maps in general (Dulamă, 2006, 2010d), using a thematic map of flowing waters.

In this activity, fourth-grade students conducted a sensory ("empirical") analysis (Zlate, 1999) when observing, identifying, and perceiving the names and characteristics of flowing waters (flow direction, length, sinuosity, or linearity of the course). By being asked to use multiple cognitive operations (comparing rivers and their tributaries; evaluating the length of river courses; ranking rivers: river, stream), students performed an abstract-level analysis (Zlate, 1999). Fourth-grade students identify and differentiate main rivers ("collectors") from their tributaries based on visible map characteristics. Students learned to compare rivers using logical criteria (Golu, 2007): flow direction, length. They learned to analyze certain characteristics of flowing waters from a territory, which they can individually establish with the help of the worksheet, guiding them toward a model or "standard" (Golu, 2007).

In the context of this learning activity, students practiced analysis as a fundamental cognitive operation (Golu, 2007; Zlate, 1999), as a cognitive process (Anderson et al., 2001), as a scientific research method (Romanian Academy, 2009, 2010; Marcu, 2000). The objectives achieved by students in this activity are categorized under "Analysis of elements" in the "Analysis" category of the objective's taxonomy (Krathwohl, 2002).

To reach a higher level of competence, fourth-grade students need mediation (Vygotsky, 1962) from the teacher, and time constraints are a limiting factor when students learn in simultaneous classes. Through this process of mediation of knowledge, students can form the competence to interpret the map, i.e., understand the relationship between the relief and the sinuosity of the river course, and the relationship between the number of tributaries and the density of the relief fragmentation.

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