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Recent Trends in the Geomorphology of Rivers and Criteria for the Degrees of Their Danger

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ABSTRACT

The study of recent trends in the geomorphology of rivers is one of the significant topics identifying the quality and patterns of modern topics and applications, as well as the criteria for degrees of dangers associated with them in international periodicals. The relative importance of recent trends in the subtopics of river geomorphology has varied. However, there is a tendency towards interest in geomorphological phenomena in the water stream, sediments, whether mechanical or chemical, and then the study of factors and processes. Accordingly, the prevailing trend is research related to geomorphological processes and phenomena rather than factors, applied aspects, and modern technologies, noting the increasing interest in modern technologies in river geomorphological studies recently. This is due to technological developments occurring worldwide and at the level of various sciences. The criteria for degrees of erosion danger are based on the general average of the agricultural property, choosing the square shape as an expression of the general shape and calculating the eroded area with it, and then finding the annual rate of the eroded part of the agricultural land. The degrees of danger resulting from the deposition process were determined based on only two inseparable criteria: the depth of the submersible and the width of the navigational channel.

Keywords: Rivers, Danger, Recent Trends, Geomorphology, Deposition Processes.

Introduction

Rivers are by far the greatest factor shaping the Earth's surface, not only in humid regions, but also in arid and semi-arid ones. They are, in essence, the great power in carving mountains, digging valleys, and building vast plains.

William Morris Davis is considered the first to distinguish between the different rivers. He classified them into three groups according to the development they pass through, namely: rivers in the youth stage (the beginning of the river's growth stages), in the maturity stage (the middle of the river's life), and in the old age stage (the last stages of the river's growth). Furthermore, these stages are not equal in their duration, but they are successive without temporal breaks

(Davis, 1999).

The water flow in rivers acquires its properties due to many complex and intertwined factors, to the extent that it is difficult to identify a single factor to be responsible for the variation in the characteristics of the running water. There is a group of overlapping factors that contribute to creating favorable conditions for the generation of this movement with its different characteristics. It goes without saying that the factors that affect the water flow in rivers are the same factors that are affected by them, and accordingly it is a reciprocal relationship. Hence, putting this relationship in the form of a regression equation, it is possible for the fixed factors to change with the variable factors (Saber & Shalaby, 2021).

The study aims to monitor and analyze the recent trends in the geomorphology of rivers in some international periodicals, including the quality and patterns of topics with the identification of modern applications used in the study of the geomorphology of rivers and how to determine the criteria for the degrees of dangers associated with them.

First: Methodology of the Study

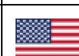
A reference and statistical study is conducted for research, published in international periodicals, dealing with rivers in general and the geomorphology of rivers in particular. The number of these periodicals reached 17 journals (Table 1), including geographical and non-geographical journals such as hydrological, engineering and environmental journals.

In addition, the analysis of Table 1 indicates the diversity in the geographical distribution of the place of publication, as 7 journals are published in the Netherlands, 5 in the United States of America, 3 in the United Kingdom, and 2 in Germany.

7185 research papers on rivers are monitored in the selected journals (Table 2), ranging from 51 papers in *Applied Geography* to 1153 papers in *River Research and Applications*. The highest percentages of the number of research papers, which exceeds 10% of the total number of monitored papers, are recorded in *Water Resources Research*, *River Research and Applications*, *Geomorphology*, and *Journal of Hydrology* (Figure 1).

Three international periodicals are selected for the analytical study in detail during the period from 1995 to 2018 (Table 3). These periodicals are *Geomorphology*, *Earth Surface Processes and Landforms*, and *Physical Geography*.

Table 1: The Most Important Scientific Periodicals Specialized in the Study of Rivers

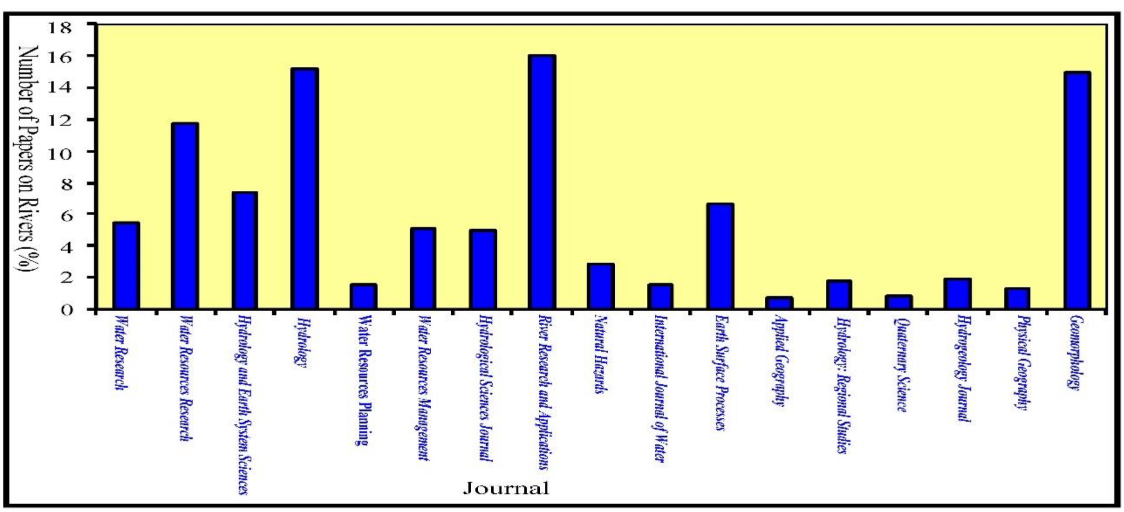
No.	Title	Impact factor	ISSN	Publisher	Country	Flag
1	*Water Research*	7.051	0043-1354	Elsevier BV	Netherlands	
2	*Water Resources Research*	4.36	1944-7973	Wiley-Blackwell	United States	
3	*Hydrology and Earth System Sciences*	4.256	1027-5606	Copernicus GmbH	Germany	
4	*Journal of Hydrology*	3.727	0022-1694	Elsevier BV	Netherlands	
5	*Journal of Water Resources Planning and Management - ASCE*	3.527	0733-9496	American Society of Civil Engineers	United States	
6	*Water Resources Management*	2.644	0920-4741	Kluwer Academic Publishers	Netherlands	
7	*Hydrological Sciences Journal*	2.061	0262-6667	Taylor & Francis	United Kingdom	
8	*River Research and Applications*	2.067	1535-1467	John Wiley & Sons Inc.	United States	
9	*Natural Hazards*	1.833	0921-030x	Kluwer Academic Publishers	Netherlands	
10	*International Journal of Water Resources Development*	1.895	0790-0627	Carfax Publishing Ltd.	United Kingdom	
11	*Earth Surface Processes and Landforms*	3.722	0197-9337	John Wiley & Sons Inc	United States	
12	*Applied Geography*	3.117	0143-6228	Elsevier BV	Netherlands	
13	*Journal of Hydrology: Regional Studies*	1.475	2214-5818	Elsevier BV	Netherlands	
14	*Journal of Quaternary Science*	2.324	1099-1417	John Wiley & Sons Inc	United States	
15	*Hydrogeology Journal*	2.071	1431-2174	Springer Verlag	Germany	
16	*Physical Geography*	1.086	0272-3646	Taylor & Francis	United Kingdom	
17	*Geomorphology*	3.308	0169-555x	Elsevier BV	Netherlands	

Source: It is by the researcher based on https://www.scimagojr.com/journalrank.php?category=1902

Table 2: The Number of Research Papers on the Study of Rivers in International Journals during the Period 1995-2018

No	Title	Number of Papers on Rivers	Percentage %
1	*Water Research*	396	5.5
2	*Water Resources Research*	845	11.7
3	*Hydrology and Earth System Sciences*	531	7.4
4	*Journal of Hydrology*	1090	15.2
5	*Journal of Water Resources Planning and Management - ASCE*	108	1.5
6	*Water Resources Management*	369	5.1
7	*Hydrological Sciences Journal*	360	5.0
8	*River Research and Applications*	1153	16.0
9	*Natural Hazards*	198	2.8
10	*International Journal of Water Resources Development*	115	1.6
11	*Earth Surface Processes and Landforms*	478	6.7
12	*Applied Geography*	51	0.7
13	*Journal of Hydrology: Regional Studies*	127	1.8
14	*Journal of Quaternary Science*	55	0.8
15	*Hydrogeology Journal*	137	1.9
16	*Physical Geography*	96	1.3
17	*Geomorphology*	1076	15.0
Total		7185	100

Source: It is by the researcher based on:
https://www.scimagojr.com/journalrank.php?category=1902



Source: Table 2.

Figure 1: The Relative Importance of the Number of Research Papers on the Study of Rivers in International Journals during the Period 1995-2018

Table 3: The Number of Research Papers on the Geomorphology of Rivers in the Selected Journals during the Period 1995-2018

No.	Title	Number of Papers on Rivers	Percentage %
1	*Earth Surface Processes and Landforms*	478	29.0
2	*Physical Geography*	96	5.8
3	*Geomorphology*	1076	65.2
Total		1650	100

https://www.journals.elsevier.com/geomorphology/editorial-board
https://onlinelibrary.wiley.com/loi/10969837/year/2018
https://www.tandfonline.com/toc/tphy20/current

The basis for selecting these journals is the following:

- The subject of the research is the geomorphology of rivers, not just rivers, and accordingly it is necessary to choose journals that show the relationships between the factor, the process and the geomorphological phenomena in rivers.
- The high credibility of these periodicals, which have high impact factor.
- The difference in the place of publication for the three periodicals (the United States of America, the United Kingdom and the Netherlands).
- Diversity in the publication of topics in the selected periodicals, consistent with the subject of the study.
- The number of research papers related to the geomorphology of rivers in the selected journals reached 1650, which is sufficient from the researcher's point of view to reach accurate results on recent trends in this specialty.

Second: Recent Trends in the Geomorphology of Rivers

The different specializations related to the geomorphology of rivers varies in the selected journals between 1995 and 2018, where river research papers are monitored or classified into 15 specializations, in addition to a general specialization (Table 4).

Table 4: The Relative Importance of Subtopic Trends in River Geomorphology Studies in the Selected Journals during the Period 1995-2018

Specialization	*Geomorphology*		*Earth Surface Processes and Landforms*		*Physical Geography*		Average %
	No.	%	No.	%	No.	%	
Riverbed Sediments	67	6.2	63	13.2	17	17.7	12.37
River Water Quality	12	1.1	13	2.7	3	3.1	2.30
Hydrology of Rivers	52	4.8	25	5.2	7	7.3	5.77
Impact of Plants and Living Organisms on the Geomorphology of the Stream	45	4.2	38	7.9	6	6.3	6.13
Impact of Climate on the Geomorphology of the Stream	41	3.8	7	1.5	6	6.3	3.87
Impact of Floods on the Geomorphology of the Stream	32	3.0	13	2.7	5	5.2	3.63
Human Impact on the Geomorphology of the Stream	111	10.3	41	8.6	8	8.3	9.07
Impact of Erosion and Deposition Processes on the Geomorphology of the Stream	130	12.1	55	11.5	5	5.2	9.60
The Delta	36	3.3	12	2.5	1	1.1	2.30
Floodplain	44	4.1	28	5.9	3	3.1	4.37
Geomorphological Phenomena in Rivers	147	13.8	65	13.6	11	11.5	12.97
Historical (Ancient Rivers)	96	8.9	18	3.8	3	3.1	5.27
Meanders	35	3.3	31	6.5	5	5.2	5.00
Technique	95	8.8	39	8.2	5	5.2	7.40
Geomorphological Hazards	39	3.6	15	3.1	4	4.2	3.63
General Specialization	94	8.7	15	3.1	7	7.2	6.33
Total	1076	100	478	100	96	100	100

https://www.journals.elsevier.com/geomorphology/editorial-board
https://onlinelibrary.wiley.com/loi/10969837/year/2018
https://www.tandfonline.com/toc/tphy20/current

A number of results related to the geomorphology of rivers in general are found by monitoring and analyzing the recent research trends of the selected journals (Table 4).

- The number of research papers related to the geomorphology of rivers in the selected journals reached 1650. The largest number recorded was 1076 research papers in the *Geomorphology* journal.
- The relative importance of recent trends related to the subtopics of river geomorphology varies between journals. In general, however, there is an increasing tendency towards interest in geomorphological phenomena in the water flow, reaching 12.9%. In the case of adding all the phenomena associated with the geomorphology of rivers in general, such as meanders, deltas and floodplains, the total percentage is close to 25% of the total number of studies. This is followed by studies related to sediment research, whether mechanical or chemical, with a percentage of 12.4%, then the study of factors and processes such as human impact, erosion and deposition processes in the geomorphology of the stream, with percentages of 9.1 and 9.6%, respectively. Hence, the prevailing trend during this period is research related to geomorphological processes and phenomena more than factors, applied aspects, and modern technologies. This is accompanied by an increase in the number of research related to stream sediments and hydrological characteristics, which is logical because it is difficult to understand the processes clearly without understanding the hydrological

characteristics, movement and quality of sediments in streams.

- There is an increasing interest in modern technologies in river geomorphological studies, such as remote sensing techniques and geographic information systems. This is mainly due to the technological developments taking place worldwide and at the level of various sciences. However, one point that is worthy of notice is that there was a significant increase in the number of research papers related to modern technologies, particularly in the period between 2007 and 2012, then there was a decrease in the recent period in regard to the title or method used in the title itself, not in the text. From the researcher's point of view, recent trends in Egypt are similar to this period, as this method spread in the titles of research papers and dissertations, where 21 master's and doctoral dissertations as well as 13 papers were monitored. This is mainly owing to the desire of researchers to keep pace with scientific trends associated with quantitative research and modern techniques.
- Egyptian studies in the geomorphology of rivers (river erosion) were comparable to many international studies and could be better than them. The reason for this is the presence of a river that is geomorphologically rich in phenomena, which is the Nile River inside Egyptian countries. Nevertheless, due to the reluctance of many geomorphological researchers to publish their research in foreign languages or to publish them internationally, there were no published papers on the geomorphology of the Nile in the selected journals.

Third: A Proposal to Define Criteria for the Degrees of Danger of River Erosion with Application to the Nile River in Egypt[1]

1. Criteria for Degrees of Danger in the Study of Erosion Processes in the Nile Stream:

The trends of previous studies, which dealt with the dangers resulting from the process of erosion in the stream of the Nile River, indicates that they classified the degree of danger in several ways, including the following:

- **The degree of slope and height of the banks:**

  The degree of danger was classified on the basis of the degree of slope and height of the banks. This classification or criterion is considered wrong, as the height and the degree of slope of the sides of the stream are considered together only influencing factors that can reduce or increase the process of erosion because they are among the most important factors responsible for the frequent collapses of the banks.

- **Width and area of the sculptured part:**

  Some studies have determined the danger criterion on the maximum width and area of the eroded part, and to see if this criterion is scientifically based or not. It has been indicated from previous research trends that the general shape of the eroded area takes different forms, it may be rectangular, square, semi-circular, or random. As a result, the maximum width and area of the eroded part may be equal, but the degree of danger is not equal because of the difference in the general shape of course. Proceeding from that, relying on the maximum width and area of the eroded part in determining the degrees of danger is not related to any real or realistic danger resulting from the process of eroding agricultural lands.

So the question arises:

How do we determine the criterion of the degree of danger resulting from the erosion process in order to represent reality? The answer, of course, depends on two criteria that cannot be separated: the area of the eroded part of agricultural land (the annual rate of the area of the eroded part) and the agricultural holding (agricultural property). They

[1] For more, see Saber (2016).

can be explained as follows:

❖ The Annual Rate of the Area of the Eroded Part

The study followed the following in calculating the area:

- Obtaining maps and visuals for different time periods (comparison period).
- Identifying the areas that have been subjected to erosion.
- Measuring the area of the eroded part of agricultural land.
- Calculating the annual rate of the area of the eroded part by dividing the total area by the time period[2].

❖ Agricultural Holding (Agricultural Property):

Agricultural holding or agricultural property is the second criterion in determining the degree of danger resulting from the erosion process. Before starting to tackle how to relate it to the eroded area in order to reach the real criterion indicating the degree of danger, several questions must be raised at the beginning, namely the following:

- Agricultural properties differ from one person to another. Accordingly, is the degree of danger equal, for example, to who owns 10 feddans and who owns 10 carats?
- The area of agricultural land varies in form from one property to another, so is the danger equal in all cases?
- The part of the agricultural property adjacent to the Nile River, which is exposed to the process of erosion, differs from one place to another. In some properties, the longest part is the one adjacent to the Nile River, and in others it may be the smaller part. Hence, the same question is raised: Is the danger equal in both cases?

Indeed, the answer to all previous questions is that the degrees of danger are not equal, and subsequently it was necessary to develop a proposal that includes all the previous factors.

In order to identify that proposal, these steps are to be followed:

- Relying on the general average of agricultural property, which in Egypt reached 2.8 feddans with an area of 11760 m2 (Ismail, 2008).
- Choosing the square shape of the agricultural property as an expression of the general shape so that the length and width of the agricultural property are equal.
- Calculating the length of the side of the square based on the total area of 11760 m^2, and hence the length of the side adjacent to the Nile River is 108.44 m. (which can be rounded up to 100 m for ease of application).
- Dividing the eroded part every 100 meters and calculating the area confined between them, then finding the annual rate of the eroded part of the agricultural land.
- Classifying the data of the annual rate of the eroded part into numerical categories on sound scientific basis.

2. Criteria for Degrees of Danger in the Study of Deposition Processes in the Nile Stream:

The phenomenon of deposition at the bottom of the Nile stream is one of the hydrogeomorphological hazards to which the Nile stream is exposed, as deposition results in problems related to the depth of the submersible and navigational bottlenecks. In this regard, the degrees of danger resulting from the deposition process were determined based on only two criteria without separating them, namely: the depth of the submersible and the width of the navigational channel. They can be clarified as follows:

[2] It is preferable to determine the time period of property of agricultural land according to the average age of the individual inside Egypt. It was determined at 72 years, depending on the general average age of the individual in Egypt, which is 71.6 years (69.0 years for males and 74.2 years for females) based on the data of the World Health Organization in 2013 (http://ar.wikipedia.org/wiki).

A. The Depth of the Submersible

During its meeting on March 12, 2003 in the River Transport Authority, the joint technical committee from the Ministries of Water Resources and Irrigation and Transport approved the specifications of the navigational channel. This was done based on the submersible depth allowed for navigation in the Nile stream, which is 2.3 meters in the case of the lowest levels of water corresponding to the lowest discharges, which in turn correspond to a discharge equivalent to 60 mm^3/day. In this case, the danger criterion is classified into only two categories:

- The first category (dangerous areas): These are the innavigable areas in which the difference between the bottom level and the water surface level is less than 2.3 meters.

- The second category (safe areas): These are the navigable areas in which the difference between the bottom level and the water surface level increases by 2.3 meters.

B. The Width of the Nagivational Channel

The width of the navigational channel has been determined to be at least 100 meters long, which can accommodate the largest tourist river units in two directions. In this case, the danger criterion is classified into only two categories:

- The first category (dangerous areas): These are the innavigable areas in which the width of the navigational channel is less than 100 meters.

- The second category (safe areas): These are the navigable areas in which the width of the navigational channel increases by 100 meters.

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