

An Overview On River Morphology Research: A Bibliometric Analysis

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Abstract: A total of 2700 publications of river morphology research in the world from 2006 to 2015 recognizes from the information facilitated in the online variant of SCI-Expanded, Thomson Reuters Web of Science, for bibliometric examination. The investigation included publication output, distribution of keywords, journals and subject areas, and performances of countries, continents, and authors. The outcomes demonstrated that 'river', 'flood', and 'restoration' were the most continuous terms in production titles, author keywords. The main three branches of knowledge were 'Geography, Physical', 'Water Resources', and 'geology'. The results similarly highlight USA must rank first as showed by as per nation shrewd examination and independent distribution as it conveyed the best number of articles followed by UK and Australia. This paper ends up the example of river morphology examine moved from investigation of material science in lower gradient stream to integrative perspective of various river biological communities and rebuilding efforts.

keywords: Bibliometric review, Citations, Publications, River, River research.

1. INTRODUCTION

River Morphology is the work of the channel design and the channel geometry at different stages along a stream channel, including the system of tributaries in the waste catchment region. The term river morphology and its equal word fluvial geomorphology use to draw the states of river channels and how they changed after some time. Climate is a noteworthy capacity, which controls river morphology. For the most part, the sum and kind of precipitation, sort of overflow, stormy and dry spell condition controlled river morphology. As a general rule, the measure of overflow, soil disintegration, the fiber of the incline next to stream likewise kept up by the atmosphere. With the guide of some episode like dissolving of ice masses, evapotranspiration, changes in sea point, expanding measure of nursery gasses in the atmosphere, an unnatural weather change and deforestation, mining additionally influenced river morphology (Bridgeland and Westaway, 2008; Jyrkama and Sykes, 2009). Because of variation in sediment budget due to human intervention channel character likewise changed. The real impact of human exercises may see as they right away make up one of the fundamental hydro-morphological elements (Walling, 2006). River channel and floodplain are to a great extent obliterated because of dams development, canalization and so forth. A few specialists investigated different effects on the stream bed like soil loss, the rate of sedimentation, water contamination, and many other men had an effect, causes channel separation (Guo et al., 2012). Time is the prevailing element in any fluvial arrangement of rivers. By the help of time, a river can change the course and rate of the fluvial procedure. Geography of fundamental rock is additionally the main part of advanced channel (Anibas et al., 2012).

Verifiable records, geomorphology, late assessment, channel morphology, geological and geophysical process additionally investigate by a few analysts (Gangodagamage et al., 2007). Amount and character of sedimentation and its effect on channel flow, morphological and sedimentary change during the time because of different effects and its impact on riverside greenery were additionally highlighted to check the river morphology (Jacobson and David, 2006; Hall and Solomatine, 2010). Stream flow and its pattern of a river also have an effect on the hydrological regime or budget of catchment area (Zhang and Schilling, 2006). River morphology investigates the interrelated and connected conduct of river with physical traits. For the most part, two sorts of system morphology found to ponder the character of the river. One is drainage system, talks about seepage design with associate the hidden rock and another is a slope incline system, investigations the example and type of stream morphology when it touches the plain (Roering et.al, 2007). A couple of analysts concentrated on limits for measuring river channel, and different structures incorporate meandering (David et al., 2009). Flood is another important character of the mature river and is responsible for the development and feeding of human civilization also. Reason like dam construction over the natural flow of the river (Graf, 2006), Urban population development (Chin, 2006) and seasonal rainfall variation (Gaume et.al., 2009) is responsible for flood development. The study of river ecosystem is useful in fisheries development, river restoration and management which help to evolve a lively feed to a river (Thorp et.al. 2006).

2. RECENT RESEARCH PROGRESS IN RIVER MORPHOLOGY

Propelled instruments like Acoustic Doppler Current Profiler (ADCP) and Acoustic Doppler Velocimeter (ADV) has created to quantify 3D stream example of the waterway. Administer of different assortments of GPS and route framework and GIS, territory estimation turns out to simple. With the help of instrument and long haul field review, we can well characterize the composition, size, and kind of bed of an evaluated stream. Channel arrangement, stream order, channel designs have turned into a highlighted area of river morphology study with the recent fluvial environment (Roy and Sinha, 2007). River morphologists use carbon dating and warm glow method to look at the phylogeny of the channel. Evolution study turns out to more comfortable with the guide of advanced, modern system (Chakraborty et al., 2010). But that vegetative part of a waterway bank additionally used as to shield the stream bank from erosion (Splinter et al., 2010). Progression in strategy and satellite-based working frameworks like RS and GIS likewise helps around there (Church, 2008). The piece of remote sensing which is talking about the different portions of Applied River Morphology are, Airborne Remote Sensing with Thermal Infrared Sensors, flood forecasting and discussion of flash flood (Cloke and Pappenberger, 2009), Terrestrial and Bathymetric LiDAR (Wilkins and Snyder, 2011), application of geophysics, Hyper otherworldly Imagery, utilizing Digital Elevation Models (DEM), to screen the development in the channel and valley design.

3. BIBLIOMETRIC ANALYSIS SURVEY

Endeavors towards this craved information incorporation include a few precise audits on river morphology research in bibliometric and another approach (Sui et.al. 2015; Wohl, 2014). While, systematic literature reviews use as a part of questioning exploration status and regularly unwind valuable points of interest that could coordinate research and approach issues in the consequent periods, such reviews address just a restricted extent of information and are unhelpful in consolidating disparate information in open research fields like river morphology, and much more so if the field of study is multidisciplinary with creation that crosses sociopolitical and scholarly fringes. The last reviews depend on the quantitative factual examination of production patterns, secured on word-clusters and carry of terms in article titles, author keywords, and KeyWords Plus, among other indicators (Khan and Ho, 2011). The quantifier of publications by document types and publication years (Wambu and Ho, 2016) are regularly used to give fundamental data about a journal. Another generally used term to include a journal is citation analysis (Fiala and Ho, 2015). In the interim, citations per publication (CPP), which could give an "observing gadget" for administration and science strategy, connected in different reviews (Ma and Ho, 2016). Markers identified with the total number of articles, independent and collaborative articles that connect to assess the examination execution of countries and continents. As of late, pointers identified with corresponding author and first author were additionally used to mass out the execute countries and continents (Fu and Ho, 2016).

River morphology is growing quickly with the development of current innovation in show time. In the event that this improvement procedure proceeds with, this teach will negligible progress inside a couple of years. The importance of river morphology is expanding step by step. There are around 72.5% territories of the world is water body and 65 - 70% components of the human body are water. For this significance, every living thing straightforwardly relies upon water and river morphology. So we can state that the fate of river morphology will be so tremendously created and exceedingly speeded every range of the world. There are incredible potential outcomes to create in future after things of river morphology. River Morphology is especially essential to the water driven designer the same number of his most prominent issues emerge on account of the type of streams realized by the transportation and statement of the residue by them. For the best possible arrangement of these issues, knowledge of river morphology is regularly essential. Among the issues in which river morphology is an essential factor is a hefty part of those managing water assets improvement and join the absolute most vital stream issues on the planet. As streams became more exceedingly created, and changes in sediments development because of stream improvements gradually wind up noticeably clear, the significance of the morphological part of river control issues will be progressively valued. One of the best commitments made by the geomorphologists to the art of river morphology is the terminology which they have presented. As already said, the Geomorphologist occupies with river morphology chiefly as a device in clarifying the cause of the present type of the surface of the earth. The science has all the earmarks of being the relatively late starting point. As per the W.M.Davis's conception, the essential activity in the form of the earth by moving water is the land or geomorphic cycle which is a go of disintegration going through a few phases. The current work designs to screen river morphology research during the years spanning 2005 to 2015. The bibliometric research information depended on Science Citation Index Expanded (SCI-Expanded) in the Web of Science Core Collection. Trends in research productivity, author contributions, and international collaboration also dissect. It expects that the outcomes would give understanding into the current research patterns and help scientists to see the course of science in river morphology research. It trusts this will in turn help analysts to distinguish and connect with information crevices towards educated mediation into the issues and the prospect of river morphology ask about towards human improvement.

4. METHODS

Documents used as a part of this review were gotten from the Science Citation Index Expanded (SCI-Expanded) database of the Web of Science database, from Thomson Reuters. The keyword phrase “River Morphology” looks as the production name in view of SCI-Expanded. Total 2700 documents from 2006 to 2015 was found and downloaded for investigation. The bibliometric pointers acronyms and terms used as a part of this review are given in Table I.

table 1: presentation of acronym utilized as a part of analysis

Acronym	Elaboration
SCI-Expanded	Science Citation Index Expanded
JCR	Journal Citation report
IF	Impact Factor
CPP	Citation Per Publication
TC 2015	Number of citations the analysed publication received from its publication to the end of 2015
C2015	Number of citations the analysed publication received in 2015
TP	Number of total articles
SP	Number of single country and continent article
CP	Number of Internationally collaborative articles
FP	Number of First Author articles
RP	Number of corresopnding author article
AU	Number of authors
PG	Number of pages

Source: (Fu and Ho, 2015)

The analysis directs on different pointers, including reference related markers (IF, CPP, the number of references from one paper's production to the finish of 2015 [TC2015] and number of references in the time of 2015 [C2015] and amount related pointers (TP, SP, CP, FP and RP). The reference record highlight of Web of Science redesign as time went on. By correlation, TC2015 was a constant reason to guarantee repeatability to give more logical and exact data. One article's C2015 computes to recognize the most recent and the most compelling research. Collaboration type of country and continents desiccate by the locations of the creators. The articles orders by the accompanying four sorts for country and continents:

- (1) The expression "single country article" allocates if the researchers' locations were from a similar country.
- (2) The expression "internationally collaborative article" assigns for those articles that were co-written by scientists from multiple countries (Tan et.al., 2014).
- (3) The expression "first author article" allocates to the articles for the examined country or continents if the address of the primary writer records from the dissected thing.
- (4) The expression "corresponding author article" relegates to the articles for the broke down country or continent, if the address of the relating writer records from the dissected thing. All record data downloads from the SCI-Expanded database into a Microsoft Excel 2010 sheet. All investigations were physically figured without anyone else outlined calculations and implicit capacities by Microsoft Excel 2010 utilizing the markers in Table I.

5. RESULTS AND DISCUSSIONS

Every single published article in river morphology inquires about amid the years 2006 to 2015 were dissected. The analyzed parameters included: document type; publication language; volume and characteristics of publication output; subject categories; publication output by journals; performance of countries and continents. Citation patterns and distribution of title words and authors' keywords in said periods were also analyzed.

1. MAIN DOCUMENT TYPE

A total of 2700 records was found inside 5 document types sorts ordered in the Thomson Reuters Web of Science. The most common document type was the research article (96.6% of the 2700 documents), followed by review papers (1.26%), conference papers (1.11%), proceeding paper (0.66%) and bulletin paper (.30%). Citation data for various document sorts break down (Table 2). The total citation, TC2015, for each document sort was steady with the total publication output (TP) inside the document types. This demonstrates higher production yield of a specific document type prompted to higher visibility and chance of citation inside that document type. It was not astonishing that reviews had higher citations per paper (CPP) than conference papers since review papers cover a more extensive view of a research theme and present facts to per users in a more coordinated way, which help readers to get a more extensive point of view of the topic contrasted with another essential document type. This demonstrates river morphology research is as yet creating as scientists in develop research fields by counsel articles from legitimate sources known for their exclusive expectations and thorough high peer-review. However, just the 2610 unique research articles found in the present work were further inspected as articles spoke to most of the peer-reviewed documents in this field.

table 2: circulation of document types of river morphology inquire about (2006-2015)

Document Type	TP(%)	TC2015	CPP
Article	2610 (96.6)	55951	21.4
Review paper	34 (1.26)	592	17.4
Conference Paper	30 (1.11)	490	16.3
Proceeding paper	18 (.66)	127	7
Bulletin paper	8 (.30)	51	6.4

source: statistical survey

2. PUBLICATION OUTPUT AND LANGUAGE

Total distribution of research articles by year of production breaks down (Fig. 1). The yearly yield of research articles expanded from around 272 articles in the mid 2005s to 314 articles in the year 2006. Production yield diminished to 218 articles in 2009 proceeding again expanding to 302 articles by the year 2014. The chart of 'number of articles' versus 'time in years' delineated in Fig. 1 raises which asserts that river morphology research is a creating study field. Every one of the distributions was in English. No other tongue could be found in these 2700 creations. So English was driving and the fundamental lingo of the distributions.

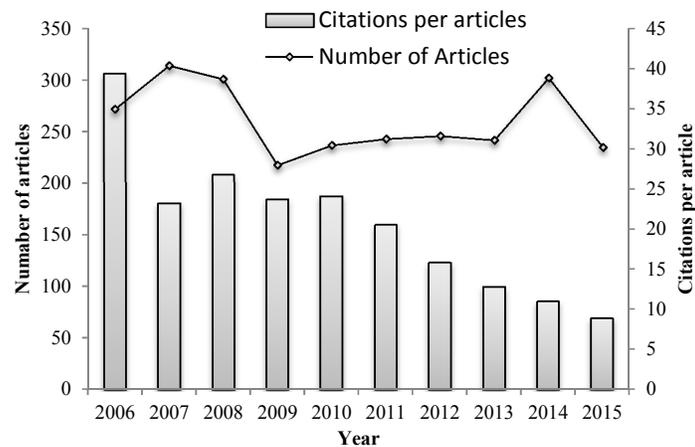


fig. 1. number of articles and citations per article by year

3. ARTICLE CHARACTERISTICS

As delineated in Table 3, river morphology research turned out to progressively collaborative over the period contemplated. The mean number of writers per article expanded from 2.3 to 4.7 and mean paper length ascended from 13.3 to 20.8 pages amid 2006 and 2015.

table 3: characteristics of river morphology journal articles (2006-2015)

Year	TP	AU	AU/TP	PG	PG/TP	CP (%)
2006	272	632	2.3	3617	13.3	65 (23.8)
2007	314	788	2.5	4404	14	78 (24.8)
2008	301	731	2.4	5338	17.7	71 (23.6)
2009	218	472	2.2	4129	18.9	69 (31.6)
2010	237	511	2.3	4389	18.5	75 (31.6)
2011	243	548	2.3	5476	22.5	82 (33.7)
2012	246	589	2.4	4490	18.2	77 (31.3)
2013	242	539	2.3	4406	18.2	71 (29.3)
2014	302	711	2.4	5321	17.6	85 (28.1)
2015	235	616	2.7	4897	20.8	80 (34)
Total	2610	6137		46467		
Average			2.4		17.8	

source: statistical survey

4. RESEARCH FOCUS ON RIVER MORPHOLOGY

Measurable investigation of recurring key terms in article titles, authors' keywords, and KeyWords Plus points of interest of research advance and demonstrates the heading of science in a research field. Distribution of title words, authors' keywords, and KeyWords Plus various periods can use to decide research core interest.

A sum of 102 title words showed up in no less than 40 research articles in river morphology ask about amid the review time frame. The main 5 most incessant title words were: "river" (523; 20% of 2610 articles), "flood" (312; 12%), "impact" (171; 6.5%), "stream" (115; 4.4%), "effect" (94; 3.6%). The analysis of authors' keywords uncovered 153 keywords that showed up in no less than 20 articles. The main 5 most successive terms in authors' keywords were: 'restoration' (207; 7.9%), 'intervention' (176; 6.7%), 'flood' (117; 4.4%), 'bed' (92; 3.5%), 'ecosystem' (62; 2.4%). Utilizing KeyWords Plus, 87 terms showed up in no less than 10 articles. With respect to the author keywords, the most regular term was 'river'(423 articles; 16.2% of all articles) followed by 'flood' (286; 11%), 'restoration' (175; 6.7%), 'stream' (103; 3.9%), 'intervention' (97; 3.7%). Accordingly, the most regular KeyWords Plus terms were more changed than the top title words, however, less different from the top authors' keywords. The term 'river'showed up in the main 5 categories crosswise over title words, authors' keywords and KeyWords Plus. Two terms, 'flood' and 'stream', were found among the top 5 for title words and authors' keywords. The simultaneous appearance of terms 'restoration' and 'intervention' in title category demonstrating the aim of river morphology investigate towards human benefit.

5. SUBJECT CATEGORIES AND JOURNAL OF PUBLICATION

As portrayed in Table 4, no less than 17 journals from 12 unique publishers published at least 100 articles on river morphology research amid the reference time frame. The main 4 journal publishers were Elsevier BV, Elsevier Limited, Wiley, Nature. Fourteen branches of subject areas added to no less than 100 articles. The top branches of subjects were (Fig. 2a and 2b)'Physical Geography' (615; 22.7%), 'Water resource' (607; 22.5%), 'Geology' (489; 18.1%), 'Multidisciplinary geosciences' (384; 14.2%). Almost 50% of the research directs in the territories of 'physical geography' (22.7%) and 'water resource' (22.5%).

table 4: top journals list in river morphology research (2006-2015)

Journal	IF 2015	TP	Percentage (%)
Geomorphology	2.813	788	29.2
Journal of Hydrology	3.053	771	28.5
Earth Science Process and Landforms	2.845	358	13.3
River Research Application	2.00	357	13.2
International Journal of River basin management	1.83	171	6.3
Water Resource Research	3.792	63	2.3
Nature	38.138	60	2.2

source: statistical survey

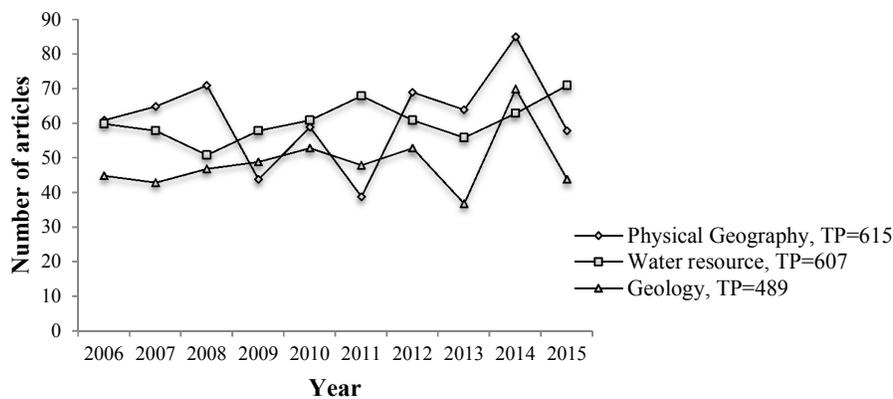


fig 2a. the number of articles from three most productive web of science categories (2006-2015)

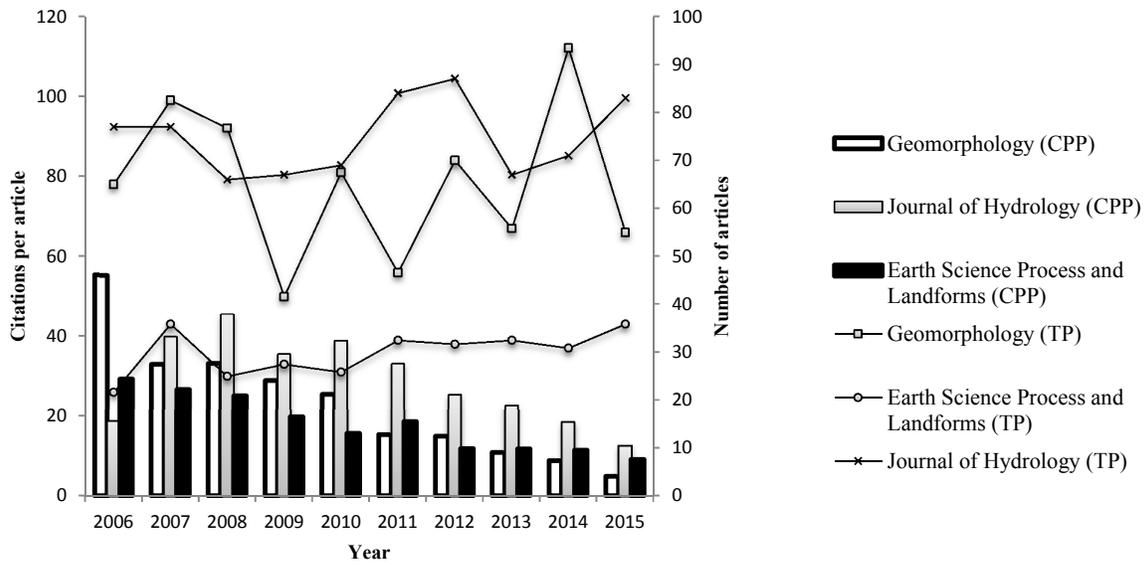


fig 2b. number of articles and cpp of top 3 productive journals

6. DISCUSSION CATEGORIES

There were different types of discussion categories for the river morphology research during this period as depicted in Table 5. The top discussion categories are Flood and related problem, River restoration and management, Construction of the dam and its effect on river, Geological and sedimentological setting of the river and Ecological character of a river. Nearly half of the research conducts in the discussion areas of Flood and related problem, River restoration and management and Geological setting of the river (Fig 3).

table 5: top discussion list in river morphology research (2006-2015)

Discussion Topic	TP	Percentage
Flood and related problem	483	18.5
River restoration and management	257	9.8
Construction of dam and its effect on river	184	7
Geological and sedimentological setting of river	373	14.3
Ecological character of a river	123	4.7

source: statistical survey

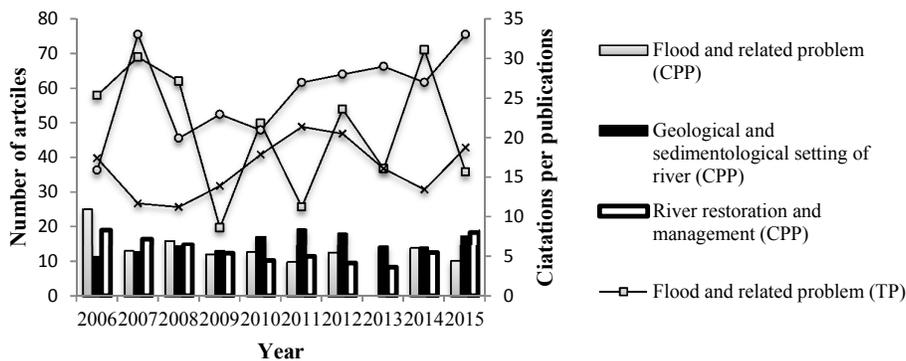


fig 3. number of articles and cpp of top 3 productive discussion area

7. **PERFORMANCE OF COUNTRIES AND CONTINENTS IN RIVER MORPHOLOGY RESEARCH**

Articles starting with England, Scotland, Northern Ireland and Wales renames as being from the UK. Articles from Hong Kong excludes in the ones from China, but rather as a country. Among the 2610 articles from the data on Thomson Reuters' Web of Science, began from 37 countries. Among those articles, 2062 (79%) were independent publications, while 548 (21%) were internationally collaborative publications. Beat 10 most gainful countries in river morphology research amid this period records in Table 6, with information about total articles, independent articles, collaborative articles, first author articles, corresponding-author articles, and single-author articles delivered. Of course, a vast proportion of river morphology research amid the 2006-2015 period distributes by writers from USA (612; 23% of all articles), trailed by those from UK (483; 18%), Australia (371; 14%) and China (311; 12%). USA and UK were the main 2 countries by the total number of publications, single-country publications, internationally collaborative publications, first author publications, corresponding-author publications and single-author publications. Moreover, the positioning of the main 4 nations stayed unaltered for TPR, FPR, and RPR, SPR. Additionally, in continents, wise case, the expansive bit of research distributed by North America, trailed by Europe and Asia. Best 3 most beneficial continents in river morphology research amid this period records in Table 7.

Table 6: Top 10 countries with more than 20 publication in river morphology research with rank:

Country	TP	TPR (%)	CPR (%)	FPR (%)	RPR (%)	SPR (%)
USA	612	1 (23)	1 (19)	1 (22)	1 (20)	1 (21)
UK	483	2 (18)	2 (17)	2 (19)	2 (17)	2 (19)
Australia	371	3 (14)	3 (15)	3 (18)	3 (15)	3 (16)
China	311	4 (12)	4 (14)	4 (15)	4 (11)	4 (14)
Spain	227	5 (9)	5 (11)	5 (12)	5 (10)	5 (11)
France	203	6 (7)	6 (9)	6 (11)	6 (8)	6 (10)
Italy	157	7 (6)	7 (8)	7 (8)	7 (6)	7 (8)
Germany	102	8 (4)	8 (7)	8 (7)	8 (3)	8 (6)
Netherland	68	9 (3)	9 (5)	9 (4)	9 (3)	9 (4)
India	34	10 (1)	10 (1)	10 (1)	10 (1)	10 (2)

Source: statistical survey

table 7: top continents with more than 40 publication in river morphology research:

Continents	TP	TPR (%)	CPR (%)	FPR (%)	RPR (%)	SPR (%)
Europe	1245	1 (48)	1 (29)	2 (30)	2 (25)	1 (36)
North America	632	2 (24)	2 (22)	1 (33)	1 (27)	2 (27)
Oceania	388	3 (15)	3 (17)	3 (21)	3 (11)	3 (21)
Asia	345	4 (13)	4 (11)	4 (18)	4 (9)	4 (14)

source: statistical survey

8. **RESEARCH COLLABORATIONS**

Countries assume a vital part in contemporary science. To evaluate trade of scientific information between the countries, the research collaboration among countries and continents were broken down. Taking all things together, 35 countries had coördinated efforts with each other in river morphology research. The most shared countries in this period, as far as accrued collaborative articles were USA (140 articles; 18% of 799 articles), UK (134; 17%) and Australia. The biggest extent of the collaborative research articles was co-authored with continents like Europe (444 articles; 56% of 799 articles), North America (161; 20%) and Oceania.

9. **ARTICLE VISIBILITY AND CITATION TRENDS**

Reader performance and logical effect of published work contemplate by breaking down the 10 most cited productions in river morphology research from 2006-2015. The rundown of the most cited articles (TC2015>100) is given in Table 8. The whole list of top cited works composed of research articles. The main subject areas secured by the 10 most cited articles were: 'river restoration' (4 articles) and 'geology' (2 article), which cites 879 times; trailed by 'river ecosystem' (2 articles), cited 225 times.

table 8: top articles with tc2015>100

Rank (TC2015)	Article title	Reference
1 (240)	Integrated optofluidics: A new river of light	Monat et.al. (2007)
2 (222)	Detection of a direct carbon dioxide effect in continental river runoff records	Gedney et.al. (2006)
3 (200)	Global threats to human water security and river biodiversity	Vorosmarty et.al. (2010)
4 (126)	Apportionment of Primary and Secondary Organic Aerosols in Southern California during the 2005 Study of Organic Aerosols in Riverside (SOAR-1)	Docherty et.al. (2008)
5 (122)	River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades	Ludwig et.al. (2009)
6 (118)	Framework for understanding structural errors (FUSE): A modular framework to drainage differences between hydrological models	Clark et.al. (2008)
7 (113)	Changes in climate and land use have a larger direct impact than rising CO ₂ on global river runoff trends.	Piao et. Al. (2007)

Source: statistical survey

Fig. 4 demonstrates that productivity of the articles expands quickly after the year 2008. Though the obvious reason for this upsurge was not quickly clear, the momentum contemplates period matched with the creative headway in river morphology study (Monat and Eggleton, 2007).

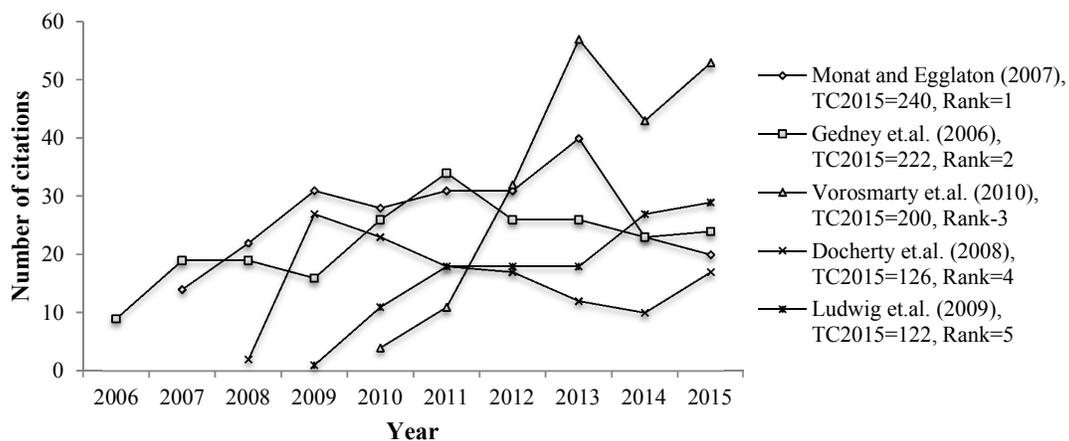


fig 4. number of citations per article by year for the main five most cited articles in river morphology research from 2006 to 2015

Visibility of articles achieved its greatest inside 2–3 years of production and diminished from that point to close to zero in 6–8 years. However, the real length of ideal scientific visibility of articles fluctuated from country to country. Articles from the USA had the meanest visibility > 2.0 citations for every article. They trailed by articles of UK (1.6 citations), China (1.3), and Australia (1 citations) origin. As seen from Fig. 5, internationally collaborative articles had the highest visibility and scientific impact took after by single-country articles and single-author articles, respectively.

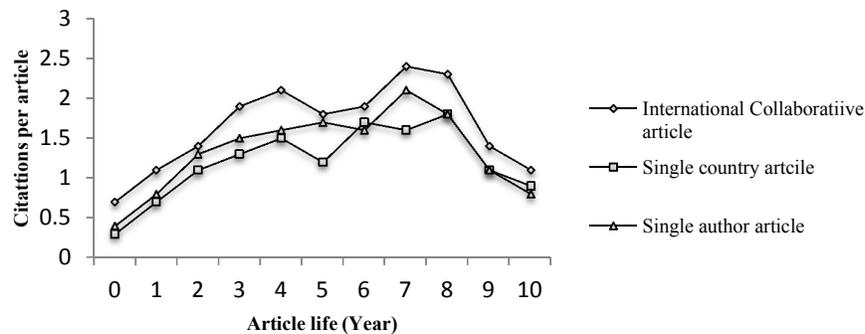


fig 5. impact on collaborations efforts of article visibility

6. CONCLUSION

A review of river morphology research amid 2006-2015 period has been given regard to annual publication outputs, Web of Science subject categories, research areas, journals, continents, countries, and trends in collaboration, research emphases, and tendencies. The distribution output in this field expanded at exponential rates over the review time frame. It shows so that river morphology research is a developing field of study. The key subject classifications of the study were: 'physical geography', 'water resource', and 'geology'. Multidisciplinary geosciences and ecology, hence, fundamentally controlled river morphology research amid this time. Research output by countries was, in any case, controlled by accessible research capital and territorial contrasts in environmental elements. Around 23% of all productions in river morphology research distributes by the USA and dispersed river morphology research by region for the rest of world followed the order: Europe > North America > Oceania > Asia. Collaborative research turned out to progressively appealing and about the part of all articles were co-authored by North American and European analysts. The most collaborative countries were USA and UK. The most astounding visibility and scientific impact of publications relate with globally collective articles.

River morphology research now puts an incredible significance on river restoration, management and attempt to shield humanity from different riverine peril. It also put awesome accentuation on ensuring of river biological community or biosphere and eco well disposed of/admirably utilization of river water. Geographic research on a widened scope of asset use and particular investigation into the spatial and natural linkages of different innovations gives off to be required. The more imperative natural water connects with each progression of our life. For this river morphology considered a huge train in the current time frame. A structure for evaluating social attractive quality still needs concocting however it could be rushed via watchful appraisal of that really takes after water asset improvement. Geographers liberated from the customary diversion among human and physical geology and with their sensibility towards the water, earth, and man, have in these the two open doors and difficulties.

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