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Department of Theoretical and Applied Informatics

Qualification work

Master

On the topic: **Statistical modeling and analysis of river networks**

Done by: 2-th year student, group MCS-54
specialty - Computer Sciences and
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Contents

Abstract

Research on river network topology is essential for understanding the hydrological cycle of watersheds, biogeochemical processes, and the health of river ecosystems. This study examines the river network topology of the Songliao River Basin by integrating GIS technology and Horton's laws. The analysis revealed key characteristics, including an average bifurcation ratio of 3.84, an average length ratio of 1.02, and an average area ratio of 0.97. These results highlight significant structural features of the basin's river network while identifying potential deviations from traditional Horton's laws, potentially due to data inaccuracies, climate change, or human activities. Future research directions include utilizing high-resolution elevation data to refine watershed boundaries and isolating human activity impacts for further validation. The findings provide valuable insights for hydrological research, water resource management, water quality protection, and flood risk assessment, contributing to the sustainable management of the Songliao River Basin under evolving environmental conditions.

Key words

River network topology, Horton's Laws, GIS, Songliao River Basin,

1. Introduction

The topology of river networks is a critical area of study in hydrology, ecology, and geographic information systems (GIS) (Karki et al., 2021). Research on river network topology is essential for understanding the hydrological cycle of watersheds, biogeochemical processes, and the health of river ecosystems (Dettinger and Diaz, 2000). The structure of river networks influences key aspects of water resource management, flood prediction, and biodiversity conservation. Over the years, studies on river networks have predominantly focused on local or regional characteristics, often overlooking the holistic and hierarchical structures that define the connectivity and resilience of river systems at larger scales (Men and Pan, 2024; Zanardo et al., 2013). Traditional methods typically involve analyzing individual river sections or sub-basins, which may miss the broader implications of network-wide dynamics.

With the advent of advanced remote sensing technologies and the widespread application of GIS, the opportunity to analyze river networks from a macro-scale perspective has expanded significantly. Remote sensing provides a powerful tool for capturing extensive data on river morphology, flow dynamics, and landscape features, while GIS offers spatial analysis capabilities that allow for efficient mapping and modeling of river networks. The combination of these technologies has transformed the study of river systems, enabling researchers to examine complex river structures in unprecedented detail (Luck et al., 2010; Thoms et al., 2018). This shift towards larger-scale, integrated approaches has contributed to a deeper understanding of river network topology and has opened new avenues for research, especially in understanding how network properties relate to ecological and hydrological processes on a broader scale.

In recent years, river network models based on complex network theory have gained increasing attention. These models offer a novel approach to studying river networks by representing them as graphs with nodes (representing river junctions) and edges (representing river segments). Such models allow for the integration of both macro-scale and micro-scale properties of rivers, providing new insights into the structure and behavior of river networks (Huang et al., 2024). Complex network theory has proven effective in examining the resilience, vulnerability, and efficiency of river networks, as it allows for the identification of critical nodes and key pathways in the network that influence flow dynamics and resource distribution. This paradigm shift from traditional hydrological modeling to network-based approaches has brought new perspectives on river management and conservation.

Globally, numerous studies have analyzed the topology of river networks using various methods. For example, Wu et al (2022) compared two algorithms—Stochastic Branching Networks (SBNs) and Optimal Channel Networks (OCNs)—to evaluate their performance in simulating real river networks. They found that while both algorithms could replicate the topological structure of real rivers to some extent, OCNs were more effective in modeling rivers with specific geometric attributes. Additionally, they analyzed the relationship between algorithm hyperparameters and node topological metrics, providing guidance for parameter selection in simulation applications. Thoms et al (2018) focused on characterizing river networks using GIS techniques. Using the Little Miami River as a case study, they applied multivariate analysis to delineate Functional Process Zones (FPZs) within the river network and examined their distribution and characteristics. This research not only enhanced understanding of river network structures but also offered new perspectives for river management and conservation. Mantilla et al (2010) approached the topic from the perspective of statistical self-similarity, testing the effectiveness of the Random Self-Similar Network (RSN) model in simulating real river networks. Their findings demonstrated that the RSN model effectively supported the statistical self-similarity of river networks, providing new evidence for understanding the fractal properties of river networks.

In contrast to global river network studies, research on the Songliao River Basin in Northeast China remains relatively limited, particularly in terms of the effects of human activities and climate change on the river network's topology. The Songliao River Basin is an essential water resource area for the region, providing drinking water, agricultural irrigation, and industrial water supply to millions of people (Chen et al., 2021). The topological structure of river networks in this region plays a vital role in maintaining water quality and quantity, which is crucial for both ecological health and sustainable economic development. However, rapid urbanization, agricultural expansion, and industrialization, compounded by climate change, pose significant challenges to the integrity of the river network and its ability to support these services (Sebestyén et al., 2022). The topology of river networks in the Songliao River Basin is likely undergoing substantial transformation due to these combined pressures, which may directly impact the distribution of water resources and ecosystem functions.

Therefore, a comprehensive study of the river network topology in the Songliao

River Basin is necessary for understanding the implications of these changes and supporting water resource management strategies. Such research can provide valuable insights into how river networks evolve in response to anthropogenic and environmental factors, and how these changes can be mitigated or adapted to. Specifically, an analysis of the basin's river network using modern GIS technologies, river network simulation algorithms, and graph theory metrics will help to identify key nodes, flow pathways, and structural vulnerabilities. Understanding these aspects will be critical for developing effective flood prediction systems, optimizing water allocation, and ensuring the long-term sustainability of water resources in the region.

This study aims to address these knowledge gaps by integrating GIS technology, river network simulation models, and graph theory metrics to analyze the topological structure of the Songliao River Basin's river network. The research will focus on understanding how environmental factors such as climate change and human activities are influencing the river network's topology. Through a combination of qualitative and quantitative analyses, the study will explore the relationships between network structure and ecological processes, providing new insights into the hydrological dynamics of the region. Additionally, it will offer practical strategies for managing water resources, reducing flood risks, and preserving ecosystem health in the face of changing environmental conditions.

2. Data and methods

2.1 Research Area

The Songliao River Basin is located between 114°E–135°E and 37°N–53°N with the highest latitude in China and includes two sub-basins, the Liao River Basin and the Songhua River Basin, whose total area is 1,248,948 km^2 (Sebestyén et al., 2022). The distribution of rivers is shown in Fig.1.

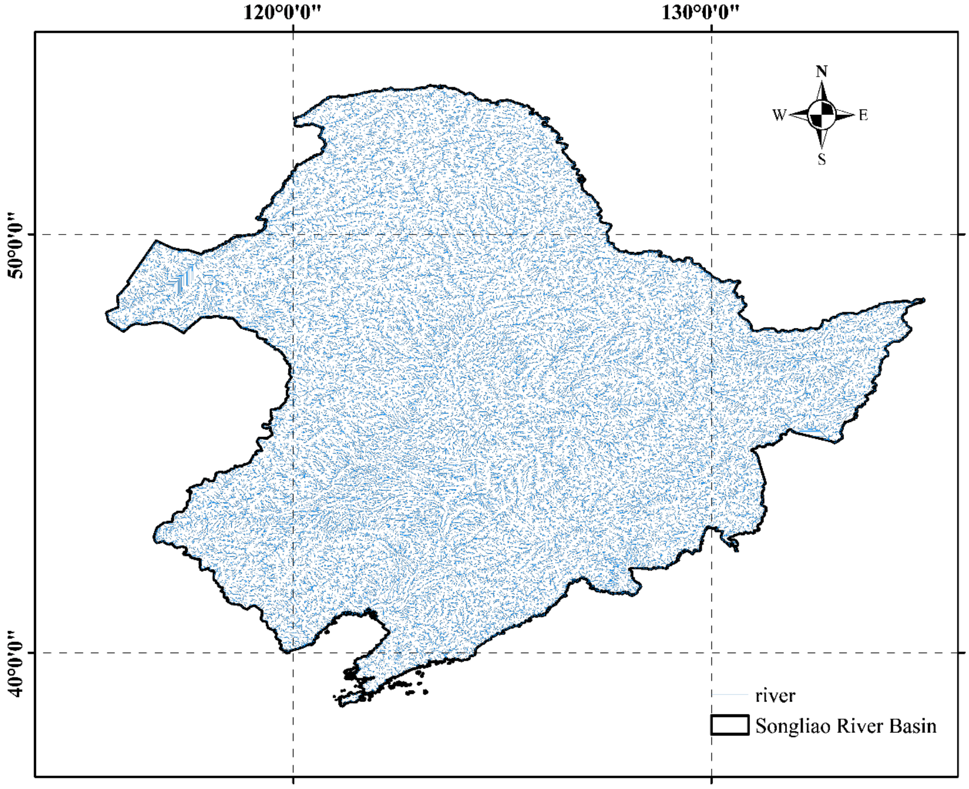

Fig.1 Research area: Songliao river basin with tributaries

The Amur River, Liao River, Yalu River, Tumen River, Suifen River, Daling River, and Ergun River are the seven major rivers in the SRB. Of these seven rivers, the largest is the Amur River, with a length of approximately 4440 km and a drainage area of approximately 8.88×10^5 km^2 in the territory of China. The largest tributary of the Amur River in China is the Songhua River, with a length of 1927 km and a drainage area of 5.568×10^5 km^2, which is formed by the confluence of the southern Second Songhua River tributary and the Northern Nenjiang River tributary (Hu et al., 2019; Song et al., 2015). The Songliao River Basin is one of the water-scarce regions in northern China. The per capita and per hectare water resources in the basin amount to only 70% and 34%, respectively, of the national averages. Moreover, water resources in the basin exhibit significant temporal and spatial variability, often misaligned with the distribution of population and arable land. Under the combined influence of natural and human factors, the basin's water resources have been steadily decreasing, leading to phenomena such as river flow interruptions. Major rivers in the Songliao River Basin have developed pollution zones along their banks, while urban water pollution is becoming increasingly severe and spreading to rural areas. This situation poses serious threats to water supply quality, deteriorates agricultural ecosystems, and exacerbates environmental challenges across the basin(Li-jie and Hong, 2005).

2.2 Date Source and Processing

River network data was collected from HydroRIVERS dataset (https://www.hydrosheds.org/products/hydrorivers). The HydroRIVERS dataset includes information on river classification, segment length, area, and other related parameters. The river basin boundary data was sourced from the **Resource and Environment Data Platform** of the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (https://www.resdc.cn/data.aspx?DATAID=141). Data processing and analysis were conducted using ArcGIS 10.8 to ensure accurate handling and seamless integration of river network and basin boundary datasets (Fig.2). The workflow included the application of statistical analysis tools to classify river orders systematically, as well as to compute and summarize key parameters such as river lengths and catchment areas. This comprehensive approach provided a solid foundation for subsequent analysis and interpretation.

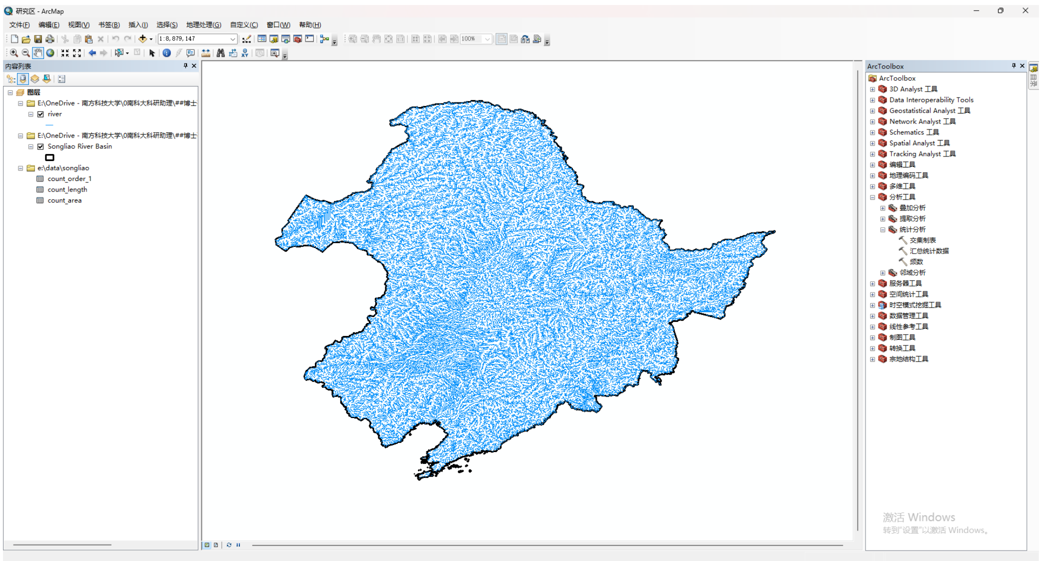

Fig.2 Snapshot of the ArcGIS 10.8 user interface

2.3 Horton's Laws

Horton's laws, fundamental in hydrology and geomorphology, describe the topological characteristics of river networks. These laws provide insights into the hierarchical structure and branching patterns of river systems:

1) Horton's Law of Stream Numbers:

This law states that the number of streams of a given order decreases geometrically as the stream order increases. Mathematically:

$$\boldsymbol{R_b}(\mathbf{u}) = \frac{\boldsymbol{N_{u-1}}}{\boldsymbol{N_u}}, \tag{1}$$

where $\boldsymbol{N_u}$ is the number of streams of order u, and $\boldsymbol{R_b}(\mathbf{u})$ is the bifurcation ratio. A consistent $\boldsymbol{R_b}$ indicates a well-organized river network.

2) Horton's Law of Stream Lengths:

This law asserts that the average length of streams increases geometrically with stream order. Mathematically:

$$\boldsymbol{R_l}(\mathbf{u}) = \frac{\boldsymbol{L_u}}{\boldsymbol{L_{u-1}}}, \tag{2}$$

where $\boldsymbol{L_u}$ is the average length of streams of order u, and $\boldsymbol{R_l}(\mathbf{u})$ is the length ratio.

3) Horton's Law of Stream areas:

This law asserts that the average area of streams increases geometrically with stream order. Mathematically:

$$\boldsymbol{R_A}(\mathbf{u}) = \frac{\boldsymbol{A_u}}{\boldsymbol{A_{u-1}}}, \tag{3}$$

where $\boldsymbol{A_u}$ is the average area of streams of order u, and $\boldsymbol{R_A}(\mathbf{u})$ is the length ratio.

The Holden ratio of the natural river network is distributed in a narrow range: $\boldsymbol{R_b}$=3~5, $\boldsymbol{R_l}$=1.5~3 and $\boldsymbol{R_A}$=3~6 (Huang et al., 2021).

3 Results

3.1 Verification of River Network Structure

The river order classification in the HydroRIVERS dataset was validated using the Strahler and Shreve ordering methods. The results indicate that the dataset's classification direction aligns with the Strahler ordering method. Specifically, rivers originating directly from sources are classified as first-order streams; when two streams of the same order converge, the resulting stream’s order increases by one; and when two streams of different orders converge, the resulting stream's order is equal to the higher order of the two original streams (Fig.3) (Strahler, 1957).

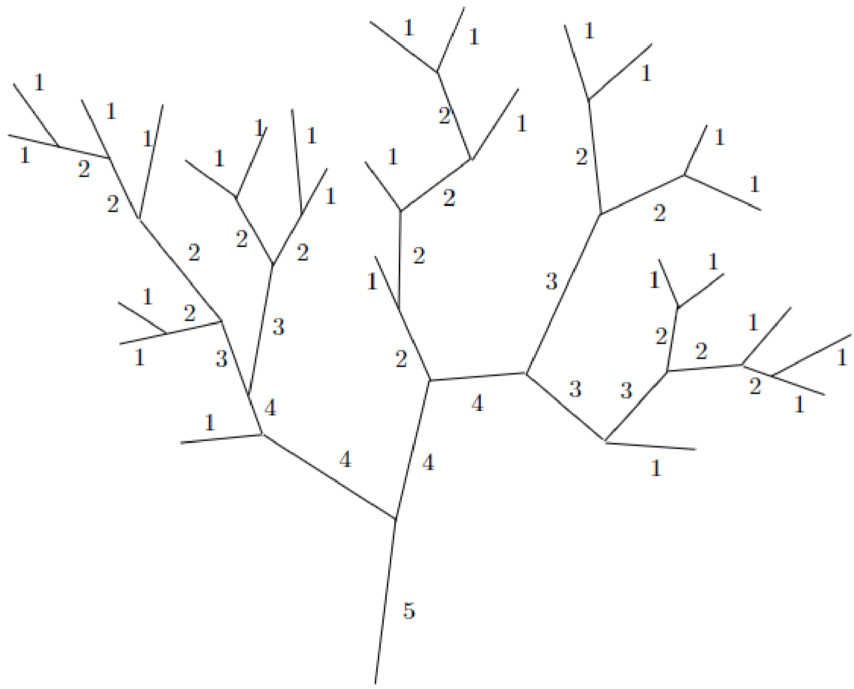

Fig.3 llustration of the Strahler rules in a given tree (Da Costa et al., 2002)

3.2 Geometric structure self-similarity

The statistical results for the stream orders of rivers in the study area are presented in Table 1 and graphically illustrated in Fig.4. The data include the number of streams ($\boldsymbol{N_u}$), total length ($\boldsymbol{L_u}$), average length ($\boldsymbol{aver\_ L_u}$), total area, average area, and Horton ratios **($\boldsymbol{R_b}$, $\boldsymbol{R_l}$, $\boldsymbol{R_A}$).** The number of streams decreases significantly as the stream order (u) increases, from 30,504 at order 1 to 41 at order 9. This trend aligns with Horton’s first law, which states that the number of streams decreases geometrically with increasing stream order. The high number of first-order streams reflects their direct origin from source areas, while higher-order streams represent the cumulative contribution of upstream flows, leading to fewer but larger rivers. This pattern is primarily attributed to the hierarchical structure of river networks, where smaller tributaries converge to form larger streams.

The total length of streams decreases with increasing stream order, though the average stream length does not follow a consistent trend, showing fluctuating values between 3.91 km and 5.23 km. The decrease in total length reflects the reduced number of rivers at higher orders. The fluctuation in average length may be influenced by the specific geomorphology and hydrology of the study area, which can create variability in channel formation and drainage patterns.

Total and average river area initially decreases with increasing stream order but exhibits a slight rebound at the highest orders. For example, the average area increases from 14.52 km2 at order 5 to 18.28 km2 at order 9. The initial decrease aligns with a reduction in stream numbers, but the slight increase at higher orders indicates the confluence effect, where larger rivers receive contributions from multiple tributaries, increasing their drainage area. The geomorphic and climatic conditions of the basin likely play a role in the observed variability, with larger rivers dominating low-lying or flatter regions.

Table 1 Statistical analysis of river parameters

u	N_u	L_u (km)	$aver\_L_u$ (km)	Area(km^2)	Aver_ Area(km^2)	R_b	R_l	R_A
1	30504	146265.44	4.79	761938.9	24.98	/	/	/
2	13706	71624.96	5.23	232202.2	16.94	2.23	0.49	0.68
3	7396	33768.69	4.57	116374.8	15.73	1.85	0.47	0.93
4	4172	17536.13	4.20	61392.39	14.72	1.77	0.52	0.94
5	2508	9948.55	3.97	36428.68	14.52	1.66	0.57	0.99
6	1083	4722.52	4.36	18560.04	17.14	2.32	0.47	1.18
7	488	1930.37	3.96	7671.73	15.72	2.22	0.41	0.92
8	737	2880.97	3.91	11442.99	15.53	0.66	1.49	0.99
9	41	212.28	5.18	749.52	18.28	17.98	0.07	1.18
Average	/	/	/	/	/	3.84	1.02	0.97

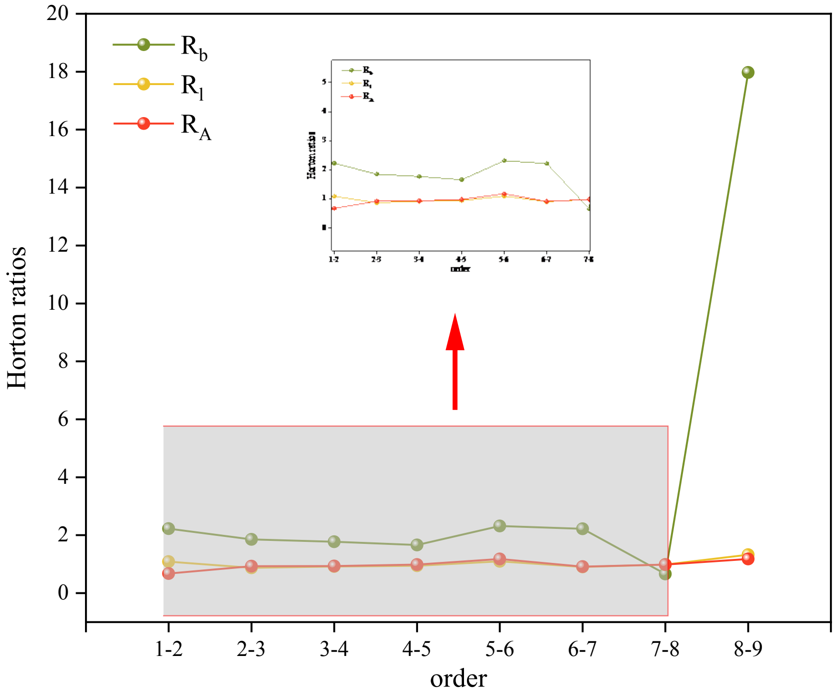

Fig 4. Horton ratios for rivers of different orders.

The average bifurcation ratio is 3.84, indicating a relatively uniform branching structure. However, there is a notable variation at specific orders (e.g., $\boldsymbol{R_b}$=17.98 at order 9, likely due to fewer samples). Higher bifurcation ratios at certain orders may result from localized geological or climatic influences, such as tectonic activity or precipitation patterns. The average length ratio is 1.02, with values ranging from 0.41 to 1.49. Lower values at higher orders (e.g., $\boldsymbol{R_l}$=0.07 at order 9) suggest stream lengths are less proportional to their order in some cases. The irregularity in $\boldsymbol{R_l}$ is likely due to variability in channel slope and sediment transport capacity, which can disrupt the proportionality of lengths across orders. The average area ratio is 0.97, showing consistency across most orders but with slight variations (e.g., $\boldsymbol{R_A}$=1.18 at orders 6 and 9). Higher $\boldsymbol{R_A}$ values at certain orders could indicate enhanced drainage efficiency or the influence of large tributaries joining the main river system.

3.3 Uncertainty Analysis

The fluctuations observed in average length and area, particularly at higher orders, suggest that this study exist uncertainties, including data quality, methodological limitations, and model assumptions.

The river network data is derived from the HydroRIVERS dataset, which may include inaccuracies in river delineation, stream order classification, and spatial resolution. Errors in stream order assignment or river segment lengths and areas can lead to deviations in Horton ratio calculations and structural metrics. Using higher-resolution datasets and validating data with field observations or additional remote sensing products can reduce these uncertainties.

The application of Horton's laws assumes idealized geometric and hierarchical properties of river networks, which may not fully capture real-world variations. The choice of parameters and thresholds in GIS-based processing, such as river segment length or flow accumulation, can influence the results. Sensitivity analysis on GIS processing parameters and testing alternative algorithms (e.g., Shreve order or Strahler order) can help evaluate the robustness of results.

Horton ratios (bifurcation ratio, length ratio, area ratio) assume consistent proportionality across stream orders, which may not hold in complex terrains or regions with significant human interventions. Anomalies or outliers in Horton ratios, such as extreme bifurcation ratios at higher orders, may reflect methodological assumptions rather than actual river properties. Incorporating additional metrics, such as fractal dimensions or drainage density, can provide a more nuanced understanding of the river network structure.

Human activities, such as dam construction, irrigation, and land use changes, can alter natural river networks, making it challenging to distinguish natural patterns from anthropogenic impacts. Climate variability and extreme weather events may temporarily or permanently modify river network characteristics.

4 Conclusions

This study conducted a comprehensive analysis of the river network topology in the Songliao River Basin by integrating GIS technology and Horton's laws. The results revealed significant characteristics of the river network, with an average bifurcation ratio of 3.84, an average length ratio of 1.02, and an average area ratio of 0.97. While these findings may differ from the traditional expectations of Horton's laws, the discrepancies could be attributed to potential data inaccuracies, the impacts of climate change, or human activities.

Future studies could refine the analysis by redefining watershed boundaries and extracting river network structures based on high-resolution elevation data. Additionally, separating the influence of human activities may help determine whether the river network adheres to Horton's laws under natural conditions.

The outcomes of this study provide a scientific foundation for advancing research on the hydrological structure of the Songliao River Basin. Moreover, they offer critical insights for water resource management, water quality protection, and flood risk assessment. These findings emphasize the importance of further interdisciplinary studies and methodological improvements to better understand the dynamics and sustainability of the river network in the context of environmental and anthropogenic changes.

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Appendix

```
public class DecisionSupport {
    public static void provideSupport(List<River> rivers) {
        double bifurcationRatio = HortonsLaws.calculateBifurcationRatio(rivers);
        double lengthRatio = HortonsLaws.calculateLengthRatio(rivers);
        System.out.println("Bifurcation Ratio: " + bifurcationRatio);
        System.out.println("Length Ratio: " + lengthRatio);
        if (bifurcationRatio > 3.0) {
            System.out.println("Consider implementing measures to reduce bifurcation to improve water flow.");
        } else {
            System.out.println("Bifurcation ratio is within acceptable limits.");
        }
        if (lengthRatio < 1.5) {
            System.out.println("Consider measures to increase the length ratio for better water distribution.");
        } else {
            System.out.println("Length ratio is within acceptable limits.");
        }
    }
}
```

```
public class HortonsLaws {
    public static double calculateBifurcationRatio(List<River> rivers) {
        int totalStreams = 0;
        int[] orderCounts = new int[rivers.size() + 1];
        for (River river : rivers) {
            int order = river.getStrahlerOrder();
            orderCounts[order]++;
            totalStreams++;
        }
```

```
        double sum = 0.0;
        for (int i = 1; i < orderCounts.length; i++) {
            if (orderCounts[i] > 0) {
                sum += (double) orderCounts[i] / orderCounts[i - 1];
            }
        }
        return totalStreams > 0 ? sum / (rivers.size() - 1) : 0.0;
    }
    public static double calculateLengthRatio(List<River> rivers) {
        int totalStreams = 0;
        double[] lengthSums = new double[rivers.size() + 1];
        for (River river : rivers) {
            int order = river.getStrahlerOrder();
            lengthSums[order] += river.getLength();
            totalStreams++;
        }
        double sum = 0.0;
        for (int i = 1; i < lengthSums.length; i++) {
            if (lengthSums[i - 1] > 0 && lengthSums[i] > 0) {
                sum += lengthSums[i - 1] / lengthSums[i];
            }
        }
        return totalStreams > 0 ? sum / (rivers.size() - 1) : 0.0;
    }
}

public class ModelValidation {
    public static boolean validateModel(double calculatedRb, double actualRb, 
double calculatedRl, double actualRl) {
        double tolerance = 0.1;
        boolean isRbValid = Math.abs(calculatedRb - actualRb) < tolerance;
        boolean isRlValid = Math.abs(calculatedRl - actualRl) < tolerance;
        return isRbValid && isRlValid;
```

```
    }
}

public class RiverClassification {
    public static int calculateStrahlerOrder(River river) {
        if (river.getTributaries().isEmpty()) {
            return 1;
        }
        int maxOrder = 0;
        for (River tributary : river.getTributaries()) {
            int order = calculateStrahlerOrder(tributary);
            if (order > maxOrder) {
                maxOrder = order;
            }
        }
        return maxOrder + 1;
    }
}

public class TopologicalAnalysis {
    public static void analyzeNetwork(List<River> rivers) {
        Graph<River, DefaultEdge> network = new
SimpleDirectedGraph<>(DefaultEdge.class);
        for (River river : rivers) {
            network.addVertex(river);
            for (River tributary : river.getTributaries()) {
                network.addVertex(tributary);
                network.addEdge(river, tributary);
            }
        }
        ConnectivityInspector<River, DefaultEdge> inspector = new
ConnectivityInspector<>(network);
        System.out.println("The network is " + (inspector.isConnected() ?
"connected" : "not connected"));
```

```java
        int connectedComponents = inspector.connectedComponents().size();
        System.out.println("Number of connected components: " + connectedComponents);
        TopologicalOrderIterator<River, DefaultEdge> iterator = new TopologicalOrderIterator<>(network);
        System.out.println("Topological order of the network:");
        while (iterator.hasNext()) {
            System.out.println(iterator.next().getId());
        }
    }
}

public class River {

    private String id;
    private int straehlerOrder;
    private double length;
    private List<River> tributaries;

    public River(String id, double length) {
        this.id = id;
        this.length = length;
        this.tributaries = new ArrayList<>();
    }

    public void addTributary(River tributary) {
        this.tributaries.add(tributary);
    }
    public String getId() {
        return id;
    }

    public int getStrahlerOrder() {
        return straehlerOrder;
```

```
    }

    public void setStrahlerOrder(int straehlerOrder) {
        this.straehlerOrder = straehlerOrder;
    }

    public double getLength() {
        return length;
    }

    public List<River> getTributaries() {
        return tributaries;
    }
}
```

表

songliao riverbasin

FID	Shape *	HYRIV_ID	NEXT_DOWN	MAIN_RIV	LENGTH_KM	DIST_DN_KM	DIST_UP_KM	CATCH_SKM	UPLAND_SKM	ENDORHEIC	DIS_AV_CMS	ORD_STRA	ORD_CLAS	ORD_FLOW	HYBAS_L12
0	折线	40013148	40013114	40017702	0.69	2633.6	6.8	10.21	10.2	0	0.031	1	2	8	412009281
1	折线	40013179	40013180	40017702	2.89	2684.6	34.7	3.83	285.2	0	0.86	3	2	7	412009286
2	折线	40013180	40013070	40017702	6	2678.6	2204.7	35.59	516366.6	0	1062.905	8	1	3	412009277
3	折线	40013220	40013222	40017702	6.84	2668.3	2214.9	28.07	526314.8	0	1099.899	8	1	3	412009281
4	折线	40013245	40013180	40017702	1.35	2684.5	2198.8	2.17	516045.9	0	1062.729	8	1	3	412009290
5	折线	40013444	40013245	40017702	2.7	2686.1	7.8	18.77	18.8	0	0.057	1	2	8	412009290
6	折线	40013534	40013535	40017702	0.55	2698.5	2184.8	0.64	515822	0	1063.489	8	1	3	412009330
7	折线	40013535	40013568	40017702	3.57	2695	2188.3	10.6	515945.1	0	1063.299	8	1	3	412009290
8	折线	40013568	40013569	40017702	3.83	2691.2	2192.1	17.24	515990.4	0	1063.213	8	1	3	412009290
9	折线	40013569	40013245	40017702	5.41	2686.1	2197.2	20.67	516025	0	1062.806	8	1	3	412009290
10	折线	40013570	40013114	40017702	32.99	2633.5	2249.8	95.83	526485.3	0	1097.393	8	1	3	412009281
11	折线	40013610	40013611	40017702	1.96	2702.1	6.9	13.65	13.7	0	0.041	1	2	8	412009330
12	折线	40013611	40013534	40017702	3.01	2699.1	2184.2	11.24	515748.4	0	1063.361	8	1	3	412009330
13	折线	40013662	40013569	40017702	1.62	2691.4	4.8	13.93	13.9	0	0.042	1	2	8	412009290
14	折线	40013710	40013611	40017702	3.01	2702	2181.2	14.18	515723.6	0	1063.322	8	1	3	412009330
15	折线	40013711	40013570	40017702	11.8	2666.5	15.6	52.61	52.6	0	0.16	1	2	7	412009281
16	折线	40013712	40013612	40017702	5.53	2626	10.2	21.33	21.3	0	0.066	1	2	8	412117130
17	折线	40013713	40013714	40017702	9.34	2612.6	2270.6	35.38	527117.9	0	1098.653	8	1	3	412009349
18	折线	40013807	40013535	40017702	3.08	2698.6	17.6	3.58	112.6	0	0.337	2	2	7	412009334
19	折线	40013837	40013838	40017702	3.08	2708.9	19	3.83	82.3	0	0.246	2	2	7	412117138
20	折线	40013838	40013710	40017702	3.82	2705	2178.3	12.65	515695.9	0	1063.238	8	1	3	412009330
21	折线	40013910	40013911	40017702	4.27	2762.4	142.3	7.03	1897.3	0	6.935	4	2	6	412009369
22	折线	40013911	40013531	40017702	7.61	2755	2128.3	33.6	509114.2	0	1035.263	8	1	3	412009329
23	折线	40013912	40013710	40017702	2.62	2705.1	6.7	13.55	13.6	0	0.04	1	2	8	412009330
24	折线	40013946	40014034	40017702	6.14	2748.4	2134.8	17.76	509294.7	0	1037.117	8	1	3	412009378
25	折线	40013948	40013949	40017702	0.93	2732.6	145.4	0.26	2163.1	0	7.571	4	2	6	412009374
26	折线	40013949	40013987	40017702	2.46	2730.2	2153	10.74	511896.7	0	1048.837	8	1	3	412009380
27	折线	40013950	40013988	40017702	2.21	2718.8	2164.5	9.33	512024.7	0	1049.213	8	1	3	412009380
28	折线	40013952	40013807	40017702	4.22	2701.6	8.6	22.24	22.2	0	0.067	1	3	8	412009334
29	折线	40013987	40013950	40017702	9.08	2721	2162.3	45.23	511965.6	0	1049.04	8	1	3	412009380
30	折线	40013990	40013838	40017702	7.4	2709	2174.3	41.27	515601.1	0	1062.955	8	1	3	412117138
31	折线	40013991	40013613	40017702	5.65	2624.7	9.5	33.49	33.5	0	0.104	1	2	7	412117130
32	折线	40014033	40013911	40017702	9.84	2762.3	2121	33.61	507183.4	0	1026.138	8	1	3	412009372
33	折线	40014035	40014036	40017702	0.28	2736.5	2146.7	0.26	509691.8	0	1041.143	8	1	3	412009379
34	折线	40014036	40013949	40017702	4.11	2732.5	2150.8	15.72	509722.9	0	1041.234	8	1	3	412009379
35	折线	40014086	40013807	40017702	3.32	2701.7	14.5	7.8	86.7	0	0.26	2	2	7	412009334
36	折线	40014116	40014117	40017702	14.62	2773.2	32.7	60.24	155.1	0	0.446	2	2	7	412009394
37	折线	40014117	40014033	40017702	1.08	2772.2	2111	1.53	507082.7	0	1022.675	8	1	3	412009372
38	折线	40014118	40014119	40017702	1.91	2745.2	2138	5.37	509522.6	0	1038.666	8	1	3	412117151
39	折线	40014119	40014035	40017702	8.5	2736.8	2146.5	46.78	509621.6	0	1040.939	8	1	3	412009379
40	折线	40014120	40013992	40017702	3.44	2607.9	8.9	13.55	13.6	0	0.042	1	2	8	412009471
41	折线	40014149	40014033	40017702	1.62	2772.2	12.9	1.53	67.4	0	0.191	2	2	7	412009372
42	折线	40014150	40014118	40017702	3.91	2747.1	16.2	5.37	70.5	0	0.203	2	2	7	412117151
43	折线	40014195	40014035	40017702	1.93	2736.9	14.4	2.05	69.9	0	0.203	2	2	7	412009379
44	折线	40014196	40014480	40017702	1.16	2658.9	6.6	11.5	11.5	0	0.035	1	3	8	412117161
45	折线	40014230	40014119	40017702	1.39	2745.3	13.2	0.9	52.4	0	0.151	2	2	7	412117151
46	折线	40014231	40013987	40017702	3.55	2730.1	8.6	24.05	24.1	0	0.07	1	2	8	412009380

0 (0 / 60635 已选择)

songliao riverbasin