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| **STUDENT NAME: Moses Bernard Velano**  **Geography Assignment Cover Sheet**  ***Your assignment/essay will not be marked unless this sheet is signed and attached to the assignment/essay.***   |  |  | | --- | --- | | **Course Code:** | GISC101-21S2 | | **Student ID Number:** | 83396373 | | **Lab Stream &**  **Tutor’s Name:** | GISC101-21S2 (C), ComA, 01  Earnest Rutherford 211 GIS Comp Lab &  Martin Nguyen | | **Assignment:** | Research Project: Part A - Analysis | | **Due Date:** | 22nd October, 2021 | | **Word Count:** | 1709 |     **STATEMENT REGARDING DISHONEST PRACTICE**  ***(in connection with the work submitted for assessment)***  The University’s interpretation of what constitutes dishonest practice includes, but is not limited to, the following:   1. **Plagiarism**, being the deliberate presentation of any material (text, data or figures, on any medium including computer files) from any other source without clear and proper acknowledgement of the source of that material. 2. **Collusion**, being work performed in whole or in part in conjunction with another person or persons, but submitted as if it had been completed by the named author alone or joint authors if a group item of work. 3. **Copying**, being the use of material (in any medium, including computer files) produced by another person or persons, with or without their knowledge and approval. 4. **Ghost writing**, being the use of another party (with or without any form of payment) to prepare all or part of an item of work submitted for assessment.   Under the University Regulations, evidence of any of these or other forms of dishonest practice by any student(s) represents grounds for disciplinary action and may result in penalties ranging from denial of credit for the item of work in question to exclusion from the University. The University’s full policy on Academic Integrity can be found at the following link:  <http://www.canterbury.ac.nz/ucpolicy/GetPolicy.aspx?file=Academic>[-IntegrityGuidance-For-Staff-And-Students.pdf](http://www.canterbury.ac.nz/ucpolicy/GetPolicy.aspx?file=Academic-Integrity-Guidance-For-Staff-And-Students.pdf)    **DECLARATION:** I have read and fully understand the statement above regarding Dishonest Practice and hereby certify that this item of work submitted for assessment is entirely my own work.  Date: 19/10/2021 |

**GISC101 Research Project**

**Part A: Data analysis, code, and report**

**Introduction:**

The rise of macroinvertebrates has been accompanied by improved health of streams in South Island, New Zealand (StatsNZ, 2020). The Macroinvertebrate Community Index (MCI) indicates the health of the freshwater ecosystem and the water quality of rivers. Macroinvertebrates are aquatic boneless organisms that are tiny but visible to the naked eye. These benthic macroinvertebrates spend their entire lifespan attached to rocks, under soaked logs, aquatic plants, and burrowed into sediments or debris (StatsNZ, 2020). It is important to consider their role in processing aquatic organic matter as it provides valuable cleansing assistance in decaying bacteria, plants, and animals that helps recycle nutrients back into the stream ecosystem. They also supply a significant food source for periphyton (algae), macrophytes (aquatic plants), rotten woods and leaves, or for themselves (LAWA, 2021). One of the challenging factors that macroinvertebrates encounter in day-to-day life is climate change, where it affects their habitats by the alteration of the temperatures in waters. The change in freshwater ecosystems, hydrological cycles, and the health of streams manifests something about how the normal existence of macroinvertebrates is affected by climate change (Ministry for the Environment, 2010).

Although MCI has been studied in detail by the StatsNZ (2020), insufficient attention has been focused on the water quality of major rivers in New Zealand. The approach of this investigation is aimed at studying the effect of median MCI scores as it indicates the overall health in South Island major rivers. The second aim is to examine the inequalities in the health status of the major rivers which can be affected by its median MCI and certain climate conditions. The importance of looking into studying the estimated median MCI and inspecting the imbalances in the health condition of the stream ecosystem is to determine the health of the biological community in streams.

**Data and Methods:**

In this project, three datasets were used, and the relevant information was summarized in (Table 1). The data that was accessed in this research are from the Ministry for the Environment that contains 512 MCI sites having 14 unique variables (Ministry for the Environment, 2016). The second dataset is from Koordinates which consisted of 680 river sites having 8 variables (Koordinates, 2008). The last dataset that was operated is from StatsNZ which had 22 Territorial Authorities containing 10 variables (StatsNZ Tatauranga Aotearoa, 2020). All three dataset was restricted in being downloaded as a GeoPackage / SQLite. By downloading each dataset by GeoPackage / SQLite in RStudio it made the data preparation easier to manage and organized. As GPKG files are not simple format instead they are tiny DBMS system package within a file, and they are efficient at supplying and storing coordinate system information (Manifold Software Limited, 2021). All the datasets had the same projection of NZGD2000 / New Zealand Transverse Mercator 2000 which let us simplify the data preparation, where no transformation needed for the projection between datasets.

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| --- | --- | --- | --- | --- |
| Dataset Name | year | source | Geometry type | projection |
| Predicted average Macroinvertebrate Community Index (MCI) score | 2016 | https://data.mfe.govt.nz/layer/52713-predicted-average-macroinvertebrate-community-index-mci-score-20072011/ | POINT | NZGD2000 / New Zealand Transverse Mercator 2000 |
| NZ Major Rivers | 2008 | https://koordinates.com/layer/306-nz-major-rivers/ | MULTILINESTRING | NZGD2000 / New Zealand Transverse Mercator 2000 |
| Territorial Authority (generalized) | 2021 | https://datafinder.stats.govt.nz/layer/105153-territorial-authority-2021-generalised/data/ | MULTIPOLYGON | NZGD2000 / New Zealand Transverse Mercator 2000 |

Table 1. Information about the datasets employed in this project

The process of analysis is divided into eight steps as depicted in (Figure 1). For the most geometric operations, the Simple Feature (SF) package was used. Firstly, the three datasets were loaded into R with the function st\_read(). The spatial operation utilized for clipping the raw MCI and river data to the area of interest (South Island) was accessing a function “st\_intersection”. This is a geometric operation that will give a result of geometries for the intersection and index of overlapping features from the second layer of origins. Now that the preparation phase has ended.

Before getting into the actual analysis, exploratory data analysis was conducted to gain a better understanding of the data. A statistic graph was plotted using relevant functions in the “ggplot2” package, showing the change of the “SiteMEdian” values against the climate condition type. The data was analyzed by presenting it in the form of a boxplot from the ggplot and defining it as “geom\_boxplot”. Then using the smoothing method “geom\_smooth” to see patterns in the presence of overplotting. Including the labels of the overall graph by utilizing the function “labs” to state the information labels of the overall graph. For a better understanding of the geographic distribution of the sites, an interactive map was created based in the “tmap” package, which also allows to showcase where those macroinvertebrates under a certain climate condition.

The main part of this analysis evaluates the overall health of the major rivers in the South Island TAs, as well as the overall health of all the rivers within each TA. The health of a river is evidenced by the statistic characteristics (mean, minimum, maximum, and standard deviation) of the “SiteMedian” values in MCI within 1 km of the river’s centerline. A 1000-meter buffer was set around each major river on the South Island using “st\_buffer” function. Following that, the buffering results are left join with the MCI data using “st\_join”. The joint results were summarized as mean, min, max, and standard deviation of the SiteMedian of MCI in major rivers located in South Island. The ‘st\_set\_geometry’ forces the geometry to be dropped and reclassing it accordingly by setting the geometries to empty values (NULL). The summary statistics for each river are then attached to the river dataset by their key variables “RIVERS” for future visualization. Based on the spatial relationship among the rivers within each TA, we evaluated the health status of all rivers within each TA by spatially joining TA and river data. The average site mean values of all rivers within each TA were calculated.

The results of exploratory data analysis were shown and discussed in the following result and discussion section. All the statistic graphs were plotted using functions based on the “ggplot2” package.

Diagram, text

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Figure 1. The workflow of the analysis

**Results and Discussion:**

The data that was accessed in this investigation showcases the overall health of major rivers in South Island. Offering an understanding of the overall health of major rivers in TA, shown in two Exploratory Data Analysis (EDA) and an interactive map displaying SiteMedian of MCI under different state of climate. Giving an insight of the correlation between South Island TA and its individual mean of SiteMedian of major rivers. The climate status in rivers within each TA are labelled as Warm-Dry (WD), Cool-Extremely-Wet (CX), Cool-Wet (CW), and Cool-Dry (CD) (Ministry for the Environment, 2010). (Fig. 2), showed that attaining a CX temperature in each TA rivers increases the SiteMedian of MCI allowing the streams to gain more nutrients from the macroinvertebrate. A significant distribution of associations of MCI and different climates shown in (Figure 3) informs that those TAs that were under the CX climate tends to contain more MCI. Grey District and Westland District manifested a CX in each river sites suggesting a cleaner and healthier streams. The abundance of macroinvertebrates is more evident in conditions where greater flows of dilution in the rivers. Moreover, as stated by the (Ministry for the Environment, 2010) observing high rainfalls gravitate to improve the water quality in the rivers. That means having greater rainfalls increases the flows in rivers, thus having higher chances of dissolved oxygen in the water which are essential to keep macroinvertebrates alive.

However, few limitations were considered in the data as some Territorial Authorities (TA) in South Island are inaccessible due to insufficient recordings by the data collectors. Consequently, revealing some Not Available (NA) values in (Table 2). The negative consequence of only looking at the categories of climate in the analysis, is it would give us insufficient findings that provides only a qualitative variable. Hence, inadequate information gives an unreliable answer to the research question. In that case, including its mean SiteMedian allows a much stronger analysis by integrating quantitative values into the graphical analysis. This validates the discovery of the overall health of rivers by having an indicator of mean average percentage of macroinvertebrates present in major rivers within each TA, coupled with some climate indicators.

The final graphical output gives an insight of where in South Island TAs had the highest mean average SiteMedian. The graph reveals an unevenly distributed MCI across the whole South Island that is measured by the mean of SiteMedian. (Figure 4) shows the variability of the health of the rivers in South Island TAs, though Westland District showing the most unusual result of having an outlier maximum value of 140.50 mean site median. Thus, the stream in that district have the healthiest water flow in contrast with the other South Island TAs.

Chart, box and whisker chart

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**Figure 2.** The correlation between the SiteMedian of Macroinvertebrate Community Index (MCI) and different categories of Climate.

Map

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**Figure 3.** Distribution of MCI sites across South Island.

Chart, box and whisker chart

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**Figure 4.** The correlation between South Island Territorial Authorities (TA) and the Mean of SiteMedian of major rivers.

**Table 2.** Mean SiteMedian of Major Rivers

|  |  |  |  |
| --- | --- | --- | --- |
| **South Island TAs** | **Mean Values of SiteMedian** | | |
| **Min** | **Median** | **Max** |
| Westland District | 104.00 | 116.36 | 140.50 |
| Waitaki District | NA | 94.97 | 110.56 |
| Waimate District | NA | 94.97 | 109.44 |
| Waimakariri District | NA | 98.63 | 104.81 |
| Timaru District | NA | 95.51 | NA |
| Tasman District | NA | 117.23 | NA |
| Southland District | 96.91 | 101.87 | 115.32 |
| Selwyn District | NA | NA | NA |
| Queenstown-Lakes District | NA | 88.27 | 96.25 |
| Marlborough District | NA | NA | NA |
| Mackenzie District | NA | 89.48 | 108.38 |
| Kaikoura District | NA | NA | NA |
| Invercargill City | NA | NA | NA |
| Hurunui District | 100.07 | 119.22 | NA |
| Grey District | 111.11 | 133.86 | 140.50 |
| Gore District | NA | NA | NA |
| Dunedin City | NA | NA | NA |
| Clutha City | NA | NA | NA |
| Christchurch City | NA | NA | NA |
| Central Otago District | NA | 96.25 | 108.71 |
| Buller District | NA | 109.70 | NA |
| Ashburton District | 100.45 | 101.68 | NA |

**Conclusion:**

In conclusion, macroinvertebrates are a great indication tool for the water quality and general health of our stream. It is essential to look at the change in temperatures in the rivers as this will help indicate the health of biological species living in the streams. Benthic macroinvertebrates are crucial for the health of the rivers in South Island as they produce terrestrial and aquatic matters (Land Air Water Aotearoa, 2021). We must consider that they best fit in Cool-Extremely-Wet (CX) water temperature as they are most likely to be populated in this climate condition and this is a good indication of the stream health. This is evidently shown in (Figure 2, 3 & 4) where indicators correlate one another. Variability is significant as the MCI around the South Island are distributed along with its indicated climate. Finally, its notable that certain climate temperature influences the mean SiteMedian of MCI which the overall health of the rivers are dependent on.

**References**

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