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Assessing and Improving Land Use on Saint Martin Island, Bangladesh: Insights from a Comprehensive Survey

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Abstract:
Saint-Martin Island, the only coral island of Bangladesh, covers an area of 8 square kilometers and is a popular tourist destination. Despite its small population of approximately 8,000 residents, effective land utilization is crucial for improving the island's economic condition. With growing population pressures and limited land availability, scientific land use planning becomes essential. This research aims to develop a comprehensive land use plan by conducting a detailed land use survey of Saint-Martin Island. A plot map was obtained from the local land office, and an onsite survey was performed to assess current land use practices. The analysis revealed that a significant portion of the land remains unused, with only 0.6% designated for farming. The majority of residents live in shanties, and multi-storied buildings are rare. Additionally, the number of educational institutions is insufficient. The study highlights the need to cease overexploitation of natural resources and convert unused lands into farmland. A strategic plan for agriculture, fishing, and sustainable resource use is recommended to ensure long-term sustainability and economic development.

Keywords: Saint Martin Island, Land use survey, Land use planning, On site survey

1. Introduction:

Due to climate change and growing population, resources are becoming scarce. Scientific planning for proper land use can help with this problem and yield better harvests. For economic growth and further development in Saint-Martin, proper land utilization is necessary. Saint-Martin is a small island in the Bay of Bengal with a very small population of 8000. The map of the island is shown in figure 1. There is no proper planning of how lands are going to be used. Sarwar Jahan proposed comprehensive research for land use planning in Saint-Martin [1]. The research mainly focused on environmentally sensitive areas, and the island was divided into six zones for that purpose. The key points of the research were overexploitation of marine and coastal resources, destructive fishing practices, and sewage and waste disposal at the ocean. The research didn't discuss how the generic lands were to be used and only focused on areas with environmental impact. This research aims to address that limitation. To make a land use plan, observation needs to be made on how lands are being currently used. Hence, the importance of land use surveys.

A land use survey is a medium via which regional analysis of an area can be done, and it gives an idea about the situation in that area [2]. Using a plot of land based on the usual characteristics of soil in that plot is called land use. Because of different soil types and environmental differences, the use of land is unique in different parts of the world. The land use survey explains those differences thoroughly and gives an idea of how the lands can be used in a better way. It also gives an idea of the impact of land use on the surrounding environment. It also shows different land use techniques along with the amount of semi-used and unused lands. It also gives insights on agricultural practices of surveyed area. Land categorization can also be done using land survey. Hugh conducted a study analyzing the purpose of a land use survey [3]. According to the study, the information that can be obtained from a land use survey is: present land use pattern, intensity of use, quality of use, direction, and rate of nature trends. Advancements in technology have helped a lot. The concept of remote sensing has become very popular nowadays. Drones and different kinds of aerial imaging techniques are being regularly used in land use surveys. Baldev Sahai used aerial images in his research that focused on a land use survey of the Idukki district of India [4]. Due to some limitations and preferences, this research was conducted via on-field survey instead of using aerial images. This process is more time

consuming but it also gives the researcher an opportunity to observe the local culture and environment which allows researcher to gain additional information to help with research. Saint-Martin Island was chosen for this study because of its unique environment and its potential economical contribution.

The remainder of this paper is structured as follows. In Section 2, literature review is presented and the methodology of this research is explained in section 3. The results of the survey are presented in Section 4 along with explanation of the result and discussion. Suggestions for better land utilization are given in Section 5. Some concluding remarks and ideas for future work are given in Section 6.

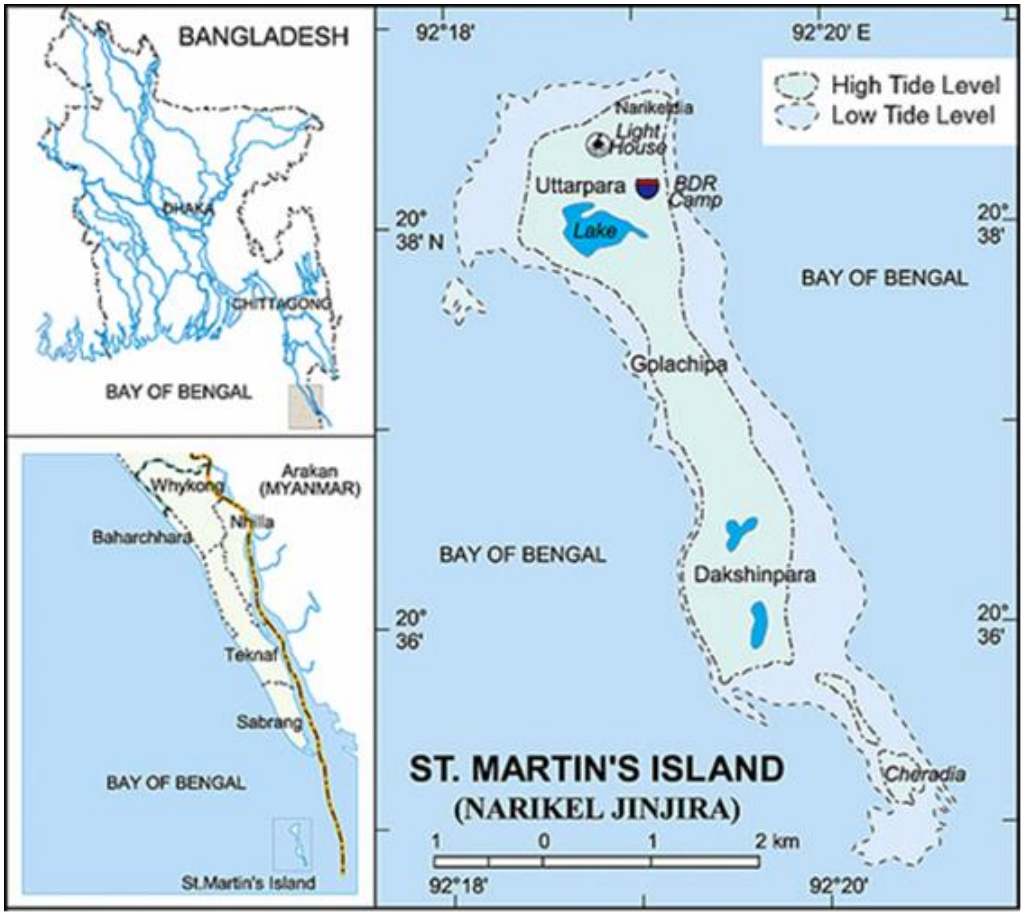

Figure 1: Map of Saint-Martin Island in Bangladesh

2. Literature Review:

Lots of research has been done in this sector, and generally each research focuses on a small region. In this section, land use studies for different locations other than Saint-Martin will be reviewed along with similar studies done on Saint-Martin.

Hugh had done one of the most important studies in this field, analyzing the purpose of a land use survey [3]. Even though the study is more than 80 years old, it is still relevant today. In his study, he discussed how a land survey should be conducted and what information can be gained from that. It's a vital study in this field and a must read for every researcher. One of the key points of the study is that land use studies are not limited to the facts of the mere location and the quantity of land being used for different purposes; they extend beyond that. In another old study, Baldev Sahai conducted a land survey on Idduki district in India via aerial imaging [4]. The research showed how remote sensing can be beneficial for land surveys. In their research, they classified the use of land into 6 types: agriculture areas, forests, wastelands, water bodies, public use, and unclassified. Each category was further divided into sub-categories to paint a clear picture of how lands were being used in different parts of the district. A similar study was done by Lin, where they used Google Earth Engine to monitor the change of land cover in Haitian Island in China [5]. The study observed the change in land cover of that rapidly urbanizing island from 1990 to 2019. According to the study, during 1990–2019, other land, cultivated land, sandy land, and water area decreased by 30.70%, 13.63%, 3.76%, and 0.95%, respectively.

Now we move onto the research on Saint-Martin Island. Not all of them were land use surveys, but they provide important information about the island nonetheless. Sarwar Jahan has done very important research that focused on environmentally sensitive areas [1]. His research further proved how unplanned use of land is harmful for the environment. The unplanned use of land and other natural resources is ruining the biodiversity of the island. Thompson also did a thorough study of the island for his book published by UNDP [6]. It is an important study to show the environmental and social realities of the island. The main economic source of the island is tourism, and the overall economic condition is far from desirable. Roy, in his master's thesis, conducted a study on land use and socioeconomics [7]. His research illustrated how land use and socio-economy changed with time from 2005 to 2020. It further showed how new economic opportunities were created and some of the past ones were being destroyed. Lands that were used for one purpose in 2005 were now used in a completely different way, and the study points out it happened along with pinpointing the changes that occurred. In another master's thesis done by Mannan was a geographical expedition of the island [8]. It focused on land use patterns and economic activities of the residents. Amin, in his research, mainly focused on groundwater resources and their sustainability [9]. The research shows that only 70.37% of the of the water is usable in the wet season and 66.28% in the dry season. A study proposed by Muhibbullah worked on finding land use patterns, drainage systems, and waste management systems in the island [10]. It clearly explained how unplanned land use is harming the environment and ruining biodiversity. Hossain, in his study, used satellite images besides ground observation to make a resource map of the island [11]. In a similar research Alam pointed out the importance of environment ethics for sustainable development [12]. They classified the use of land and soil into different types, which they marked down in their map. Recently, an extremely important study was conducted by Ahmed that focused on the impact of climate change on the island [13]. Significant changes in land use and land cover were found in the study, with a considerable increase in developed areas among them. It also noted that, from 1977 to 2018, the average tidal fluctuation increased by 0.30 meters. The study also showed that sea-level rise is causing a general decrease in land area.

The main thing that can be observed from this literature review is that most of the studies focused on the environmental situation of Saint Martin Island and were very focused on the general use of land, from farming to infrastructure building. The few that did focus on that are quite old, showing the necessity of a new research of the island to observe the changes made during that time and how the lands are currently being used for different functions.

3. Research Methodology:

Figure 2 illustrated the methodology of the research. At first a map was collected, then an onsite survey was conducted to find out the use of each plot shown in map. Using the finding of the survey a thorough survey report was done. After that the report was analyzed in details to find out the problems in current land use technique and potential methods to use lands more efficiently. Finally, based on the analysis some suggestions were given to improve the use of land for better outcome. During the on-field survey people were interviewed, soil quality was also checked was along with multiple other steps of the survey. Each of these things provided valuable information for the survey.

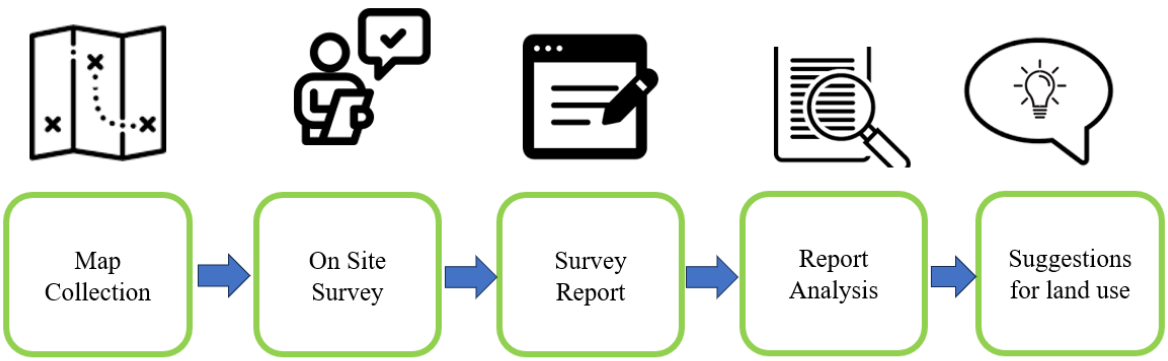

Figure 2: Methodology

A. Map Collection

The first step of this research was collecting a plot map of Saint-Martin Island from a local land office. The map is shown in figure 3. The map is also based on surveys conducted in 1970-1982. Considering how old the surveys are; they are obviously of no use. The only reason of using this map is because the whole island is segmented in different plots. For this research it was observed how each plot was being used currently.

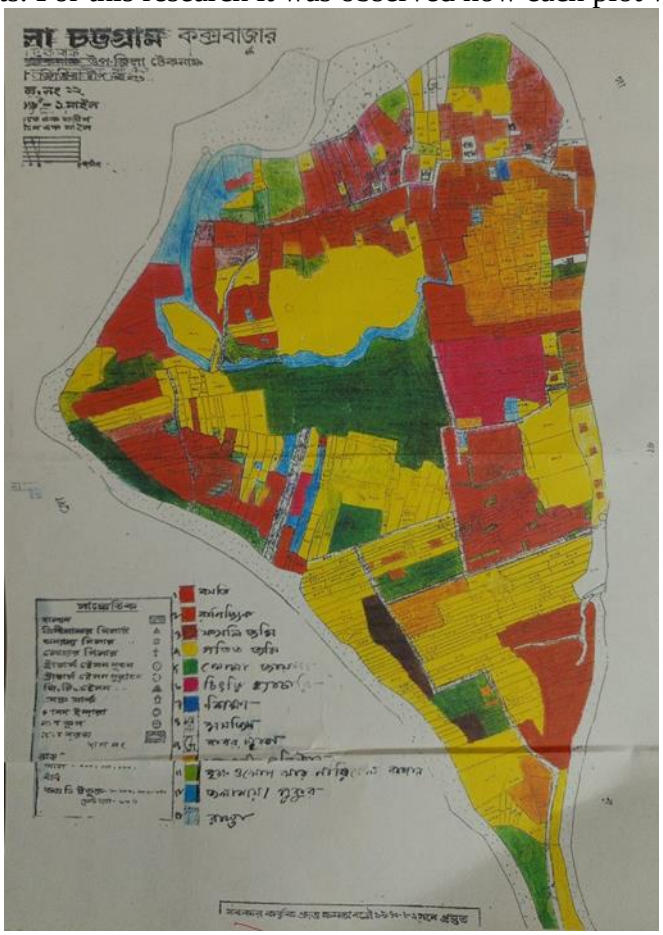

Figure 3: Plot map of Saint-Martin Island

B. On Site Survey

Each of the plot shown in the map were visited and the use of the plot was noted down. It was a lengthy and time-consuming process. But observation was made for every plot. And just as anyone would assume; lot of the plots were used for a completely different purpose than shown in the map. Some local farmers and residents were also interviewed to have a better grasp of the situation. Few pictures of the surveyed area are shown in figure 4.

Figure 4: Photos of surveyed area

C. Survey Report

Based on information of sites survey report was made. The report covers every aspect. The key points of the report are shown in figure 5. The report was extensive and consisted every minute detail of the survey. The interview questions, answers and other information were represented using appropriate graphs, charts and tables. The on the ground reality of the survey and limitations were clearly written in the report for better understanding of possible biases in the survey. Background of people that were interviewed were given and people different background were interviewed for an actual picture of the situation.

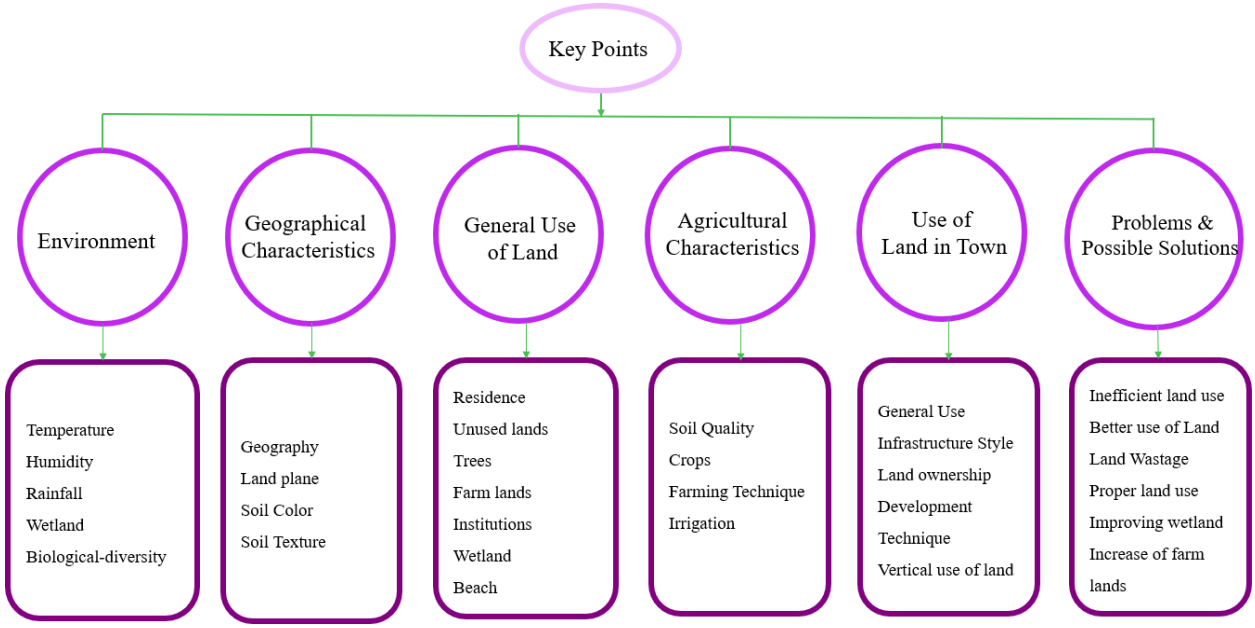

Figure 5: Key Points of Survey Report

D. Result Analysis

The report was then analyzed thoroughly. The results of the survey and detail discussion is shown in section 4. The survey report was written in details. The figure 5 is an example of that; it shows an hand written map where the vertical use of land is displayed. The map is of Majherpara; one of the villages in Saint-Martin Island. Every aspect was considered and detailed explanations are given to identify the problems and their possible solutions.

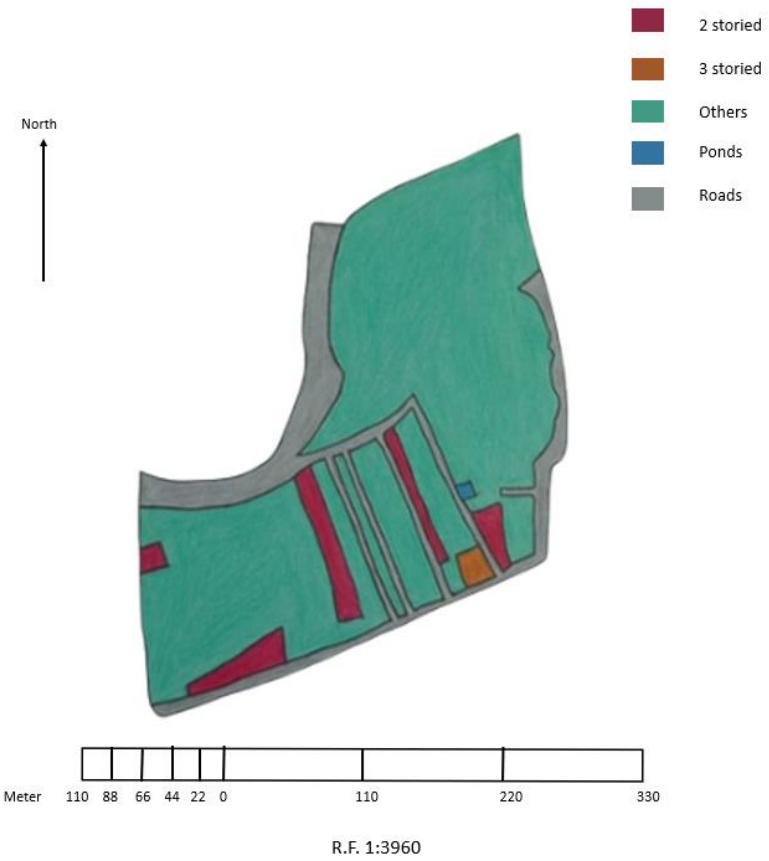

Figure 6: A hand drawn map of one of the surveyed areas (Majherpara) from the survey report

E. Suggestions for Land Use

After analyzing the report suggestions were given how to use land properly. This is discussed in details in section 5. The solutions that are given are made after accessing the current situation and the implantation of those solutions will lead to a sustainable development of the island. To conserve and maintain the biodiversity of the island is extremely important. The rapid climate change will make the situation only worse with time. Scientific use of land with an aim towards sustainability is the only way forward.

4. Results and Discussion:

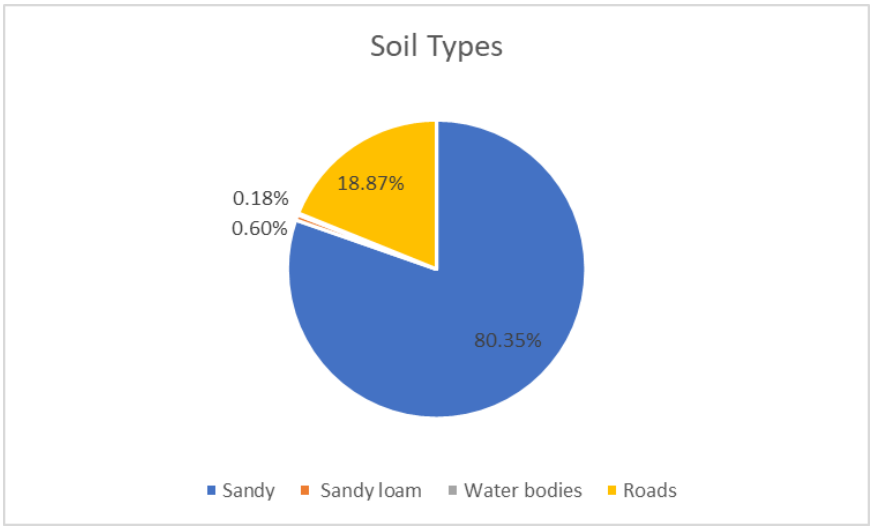

Figure 7: Amount of area for different soil types

From figure 7 we can see most of the land in Saint-Martin are sandy and only 0.6% lands are sandy-loam. Meaning the amount of cultivable land is measly 0.6%. The amount of water bodies is only 0.18 % and 18.87% of the island is used for roads.

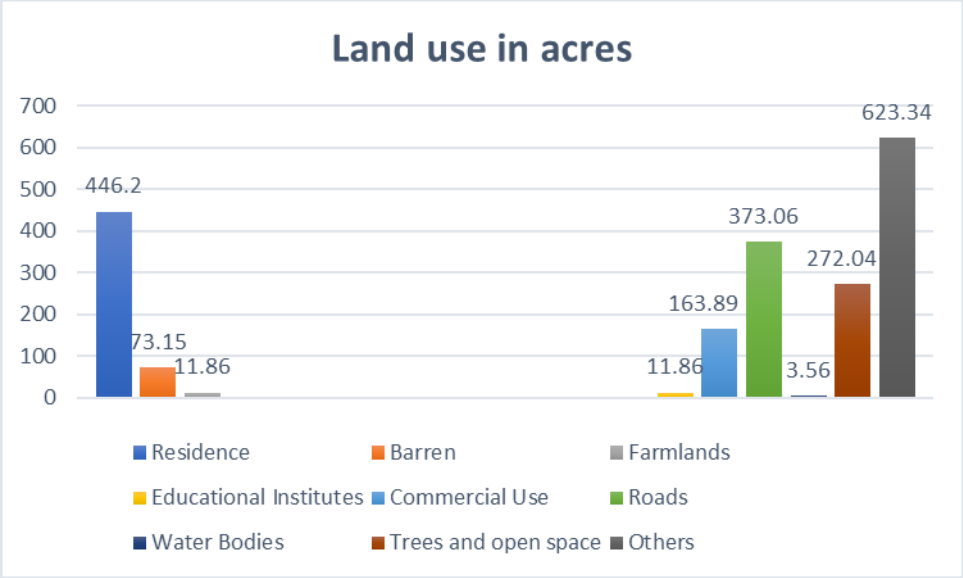

Figure 8: General use of lands in acres

Figure 8 illustrates the general use of lands in the island. Approximately 446.2 acres of lands are used for residence, 73.15 acres lands are barren/unused farmlands, only 11.86 acres are used for farming; a similar amount of land is used for educational institutes. 163.89 acres are used for commercial use. It shows the most of the land is used for residents and the number of farmlands is extremely low.

The harvesting techniques of those farmlands are show in figure 9. Among the 11.86 acres of farmland only 29.41% are used for multi cropping and the rest are used for farming two crops annually. This might seem like a good practice in hindsight but in reality, it doesn't stop overexploitation of lands and underproduce necessary agricultural products.

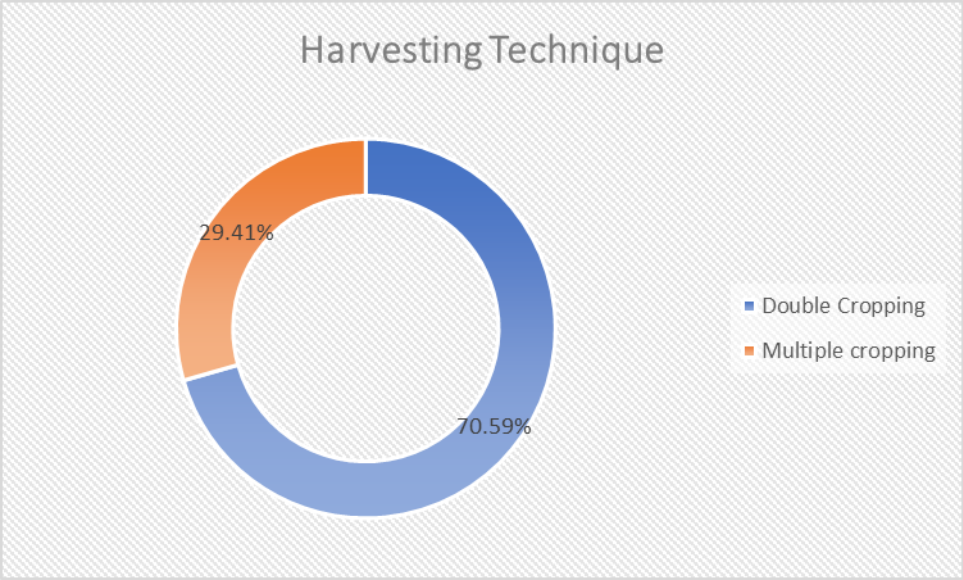

Figure 9: Harvesting Techniques

Table-1 shows that most of the land in the island is not in use. 4.69% are used for private properties and only 3.70% are used by governmental institutions.

Table 1: Ownership Type

Ownership Type	Percentage
Private Properties	4.69%
Government Properties	3.70%
Others (not currently in use)	72.57%
Roads	18.87%
Waterbodies	0.18%

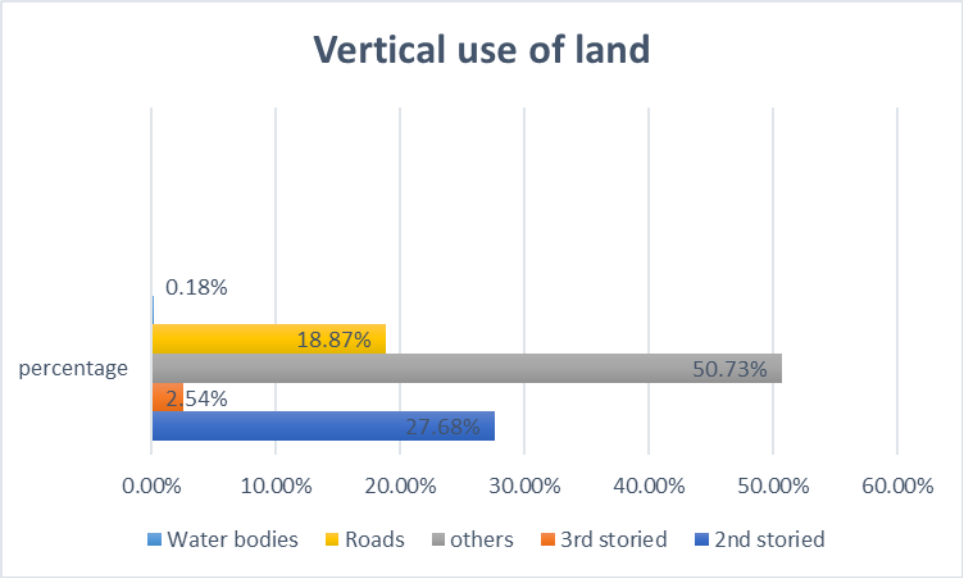

Figure 10: Vertical Use of land

In figure 10, the vertical use of land is displayed. Most of the people in the island lives in shanties. A very small number; 2.54 % of total areas used by multi-storied building. The amount of land used by two storied building is 18.87%.

Let summarize all the finding of the survey. The environment of Saint-Martin is what you would expect from a tropical island. Due the high number of coconut tree it's called 'Narikel Jinzira'; Jinzira is the local land of the island. It's warm and the temperature stays almost same all around the area. During monsoon south east part of the island. Humidity fluctuates between 70%-87% around the year. The most of the soil is sandy and not suitable for farming. Except for Keya (Screw Pine: Pandanus tectorius) forest and Mangrove Forest in the south; there is no other natural forest. Around 56 species of coral, 187 species of snail and oyster, 157 species of gymnosperms, 240 species of sea fish, 120 species of bird and 19 species of mammals can be found in the island. There is not much waterbodies in the island. Most of the lands are barren or unused and a very small number of lands are used for farming. 22.57% of the land is used for residence and the amount of trees are very minimum. Most of the local population live in shanties. The buildings that are found in the island are mostly resorts for tourist. The economy of the island depends completely on tourism. The locals are involved in various professions related to tourism. So, there is no focus on improving agricultural sectors. The biodiversity of the island is being destroyed by overexploitation of resources. Keya forests are being destroyed for building resorts. Protected areas are being used by influential people. Finding out the accurate ownership type of lands in the island is extremely tough due to this reason; due to political implications accurate information can't be gathered. To protect the ecology of the island strict measures, have to be taken to stop overexploitation, reserved areas can't be used, and have to monitor every little change in biodiversity of the island.

5. Land Utilization Techniques:

Recent Studies has suggested how land can be better utilized [14-15]. Following those guidelines would improve efficiency of land use. Barren lands are need to be turned into farmlands; even though most of them are sandy soils. They can be used for harvesting by using proper fertilization techniques and planting trees in accordance with soil type. Same piece of land shouldn't be used every time as it degrades the quality of the land and doesn't provide good harvest. Since, the number of water bodies are very small; artificial ponds, wells should be created to help with irrigation. Harvesting method is still rudimentary and modern harvesting methods need to be introduced for better harvest. Unplanned development should be stopped and exiting residence should be rearranged. So, the main points are:

- Stopping wastage of land by unplanned use of lands
- Proper use of barren land around settlements
- Rearrangement of settlements
- Revitalization and improvement of water bodies

- Increase of farmlands
- Tree conservation and forestation

If all these things are implanted it will result in a better economic situation for the residents and it will be better for the environment of the island. The natural beauty of the island can be preserved and the tourism industry will keep flourishing.

6. Conclusion:

Saint Martin is a land of unparalleled beauty. It's rich in natural resources, and biodiversity is vast. It is a popular tourist destination because of its natural beauty. The environment on the island is declining due to both climate change and unplanned land use. This study was conducted in an effort to shed some light on the current realities of the island. A land survey via satellite imaging will show the land use, but the explanation of why and how it is being done can't be explained. For that purpose, an on-field survey was performed to observe every detail and to have a proper understanding of why the lands are being used in that way. Based on that survey, a report was prepared, and by analyzing that report, the situation of the island can be understood. The lands are not suitable for farming, and very few farmlands are available. The number of educational institutes is insufficient, and most of the residents are illiterate. Most of the people live in shanties. The multi-story buildings that are found are mostly resorts and government institutions. The harvesting method is primitive, and there is no planning on how to utilize land properly. Conservation areas and forests are being destroyed; natural resources are being overexploited, which puts the biodiversity of the island at risk. With rising sea levels, the number of drinkable water sources and farmlands will decrease even more. To handle all that as best as it can be done, a proper guideline is given based on the analysis. More waterbodies need to be created for drinking water and irrigation use, barren lands need to be turned into farmlands, modern methods of farming need to be introduced, farmlands need to be swapped every few years to stop overexploitation, forests and biodiversity need to be preserved, settlements need to be rearranged, and the development of the whole island should be planned centrally to maintain consistency. If all these steps are taken, Saint-Martin will regain its glory; otherwise, the island will lose everything that makes it great. The beautiful island is in the ruins of human action.

Limitations:

Due to limited resources some scientific equipment was not used. Collecting information proved difficult because of lack knowledge of the residence about surveys and political situations of the island. Soil quality, waterbodies and water management results were made only by observation and not by other scientific methods.

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