TRAFFIC CONGESTION AND ROUTE CHOICE ANALYSIS BETWEEN TWO ROUNDABOUTS BASED ON GIS ROAD NETWORK DATA MODEL

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KEYWORDS: Level of Service, Geocoding, Link Count

ABSTRACT: Nowadays, Yangon with a population of 5.24 million becomes a largest commercial city and a hub of international trading center in Myanmar. The population and traffic demands have significantly increased in Yangon City due to government policy changed in 2010. The main objective of this study is to analyze traffic congestion and route choice behavior between two roundabouts, the most traffic congested area in Yangon City. We used the roadside interview method for one thousand and five hundred vehicles to collect their origin-destination, route choice. We also collected existing road characteristics such as width, numbers of lanes and signal timing of between two roundabouts to calculate Level of Service (LOS) using HCM 2000. After that, we converted our roadside paper-based traffic survey data into geospatially enabled traffic survey data by utilizing Geographic Information System (GIS) road network data model and geocoding method. We used this geospatially enabled traffic survey data to measure travel distance, road usages and then compute link count or volume for the individual road segment. Finally, we analyze drivers’ route choice behaviors and traffic congestion by road segments. We hope that this study will help to solve current traffic congestion problems and support future transport planning in Yangon City.

1. INTRODUCTION

Knowledge of the travel patterns for a defined jurisdiction or roadway network is an important aspect in transportation planning (Proussaloglou et al., 1996). The patterns may include vehicle classifications, trip purposes, travel time, age differentiation, lifestyles, and vehicle occupancy among others. The information can be used for different purposes including traffic impact studies, corridor and area planning, zoning, master plans, traffic projection, and traffic assignments.

Routes and network are the interconnected features that are used for transportation and include highways, railways, streets, rivers, transportation router (transit, school, buses) and utility systems. Road Networks are an important part of our everyday movement from place to place and analysis of these networks improves the movement of people, goods, services, and the flow of resources (Irfan Ali Memon, 2005)

Geographic Information System (GIS) technology is more useful in management functions and decision support systems which are more helpful in the planning process of urbanization. The various applications of GIS can be used for identification of road network area and change detection in the road. These applications of GIS can be used in traffic control to generate the traffic control mechanism that provides the fastest route (Gawali et al., 2013)

According to the 2014 census data of Yangon is 5.24 million which indicated increases in population growth which is as a result of the center of private and public business. Due to the rapid urbanization, vehicle ownership and traffic volume have significantly increased. Thus can causes accumulations of vehicles on the road and service of roadway is more than its capacity. Traffic congestion has seriously affected not only to the environment at to people’s daily activities.

Since there is a lack of systematic information and management plan for the road network, new approaches have to be used in identifying, analyzing and planning for future urban transport planning

The specific objective of this paper is to analyze drivers’ route choice behaviors and traffic congestion by road segments by utilizing GIS road network data model and geocoding method. The second part is to calculate the lane capacity and LOS of the intersection of the survey area.
2. LITERATURE REVIEW

The simplest GIS tools that can be used for traffic congestion GIS application is related to displaying and querying spatial and attribute data. For example, ArcGIS software has several functions that can be used for data query and display. This software can display attributes in relation to points, lines or polygons, otherwise known as thematic mapping (Ajay D. Nagne and Bharti W.Gawali, 2013). Shortest path analysis is an essential precursor to many GIS traffic applications (Grimshaw D., 2000) The US.DOT Travel survey manual (1996) provided the license plate survey, roadside handout survey, roadside interview survey. Cambridge Systematics Inc.1 identified that increasing analytical demands on the survey data to support more robust statistical analysis. Demand for increased efficiency and higher quality of the survey. A review of travel surveys conducted in California between 1990 and 1996 provides some insight into the variability of response rates. For ten license plate surveys, the response rates range from 11% to 43%.road side interview survey of origin and destination is used in this paper due to its availability of exact and reliable information (Washington state department of transportation, 1998). The study can provide not only travel distance, road usages and volume but also travel pattern of daily commuter and plan for future urban transportation planning.

3. STUDY AREA

Yangon is located in Lower Burma (Myanmar). According to the 2014 census data, 5.24 million people live in Yangon and city's area is 598.75 square kilometers. Population increased from 4.9 million in 2002 to 5.24 in 2014 that caused high population density and high traffic demand. Yangon has a 4,456-kilometre (2,769 miles) road network of all types. The survey area is at the intersection of U Htaung Bo Road, Ar Zar Ni Road, and Shwedagon Pagoda Road that is located between Uwisara and U Htaung Bo roundabouts (Figure1). This place is always congested even at the weekend as this is one of the main routes that connect the central business district (CBD) area and other townships.

Figure 1. Roadside Interview Survey Station
4. METHODOLOGY

This study aims to analyze the route choice behaviors of the road user at the congested place with the use of manual data collection method, geocoding and road network model in GIS application.

Firstly, the collection of the existing traffic volume is carried out to calculate the congestion level of the existing traffic condition. Manual counting method is used for data collection in this paper. Traffic volume is collected from 8:00 AM to 10:00 AM. The result data are then used to evaluate the existing traffic congestion level and to decide the number of sample size for the interview survey. Interview survey method is used in order to analyze the route choice behavior of the road user who entered the congested study area. The interview questionnaires include Route choice, origin, and destination of the road user, their trip purpose, and travel time. The sample size for the questionnaire is 30% of the existing traffic volume per hour. The survey station is at the intersection of U Htaung Bo Road, Ar Zar Ni Road and Shwedagon Pagoda Road that is located between two roundabouts. Four interviewers interviewed for three days from 8:00 AM to 6:00 PM. Among various Origin and Destination survey methods, like (postcard survey, registration number survey, taxi survey, and roadside survey), this paper used a roadside survey method. Next, convert the interviewed data to geospatial data by utilizing GIS road network data model and geocoding. Finally, route choice behavior of road user is analyzed Figure 2.

5. RESULT AND DISCUSSION

5.1 Lane Capacity and Level of Service

Lane capacity, traffic signal timing, and level of service (LOS) of the study roadway is discussed in this section. Level of service is one of the most used parameter that evaluate the congestion level. LOS is calculated by diving the actual traffic volume by capacity of the roadway using highway capacity manual (HCM, 2010).

Road Capacity, C

\[ C = \text{saturation} \times N \times \text{fw} \times fHV \times PHF \times \text{g/c} \]

(1)

Where,

N = number of lanes (one direction)

fw = adjustment factor for lane width = 1+(w-12/30)

fHV = adjustment factor for heavy vehicle = 100/100+HV(ET-1)
Effective green time for Ar Zarni Road is significantly lower than for U Htaung Bo Road approach to U Htaung Bo roundabout and for Shwedagon Pagoda Road. U Htaung Bo Road approaches to U Wisara roundabout also have less green time compared to its traffic volume. Table 1. Level of service (LOS) evaluated from volume by capacity ratio show ‘F’ in all directions except from left turn of eastbound direction. This indicated that congestion condition is seriously bad. Therefore OD and route choice of the road user is needed to analyse to understand the pattern of daily commuter and plan for the future improvement of current situation.

Table 1. Lane Analysis

<table>
<thead>
<tr>
<th>Lane Analysis</th>
<th>U Htaung Bo (EB)</th>
<th>U Htaung Bo (WB)</th>
<th>Pagoda (NB)</th>
<th>Pagoda (SB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturation flow, s</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
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<tr>
<td>Effective green time (sec)</td>
<td>300</td>
<td>600</td>
<td>180</td>
<td>600</td>
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<tr>
<td>Cycle length, c</td>
<td>747</td>
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<td>747</td>
<td>747</td>
</tr>
<tr>
<td>g/c</td>
<td>0.402</td>
<td>0.803</td>
<td>0.241</td>
<td>0.803</td>
</tr>
</tbody>
</table>

Table 2. Level of Service

<table>
<thead>
<tr>
<th>Capacity Analysis</th>
<th>U Htaung Bo(EB)</th>
<th>U Htaung Bo (WB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>v/c ratio</td>
<td>LT</td>
<td>TH</td>
</tr>
<tr>
<td>LOS</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>Pagoda(NB)</td>
<td>LT</td>
<td>TH</td>
</tr>
<tr>
<td>v/c ratio</td>
<td>1.27</td>
<td>1.27</td>
</tr>
<tr>
<td>LOS</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

5.2 Analysis of Drivers’ Route Choice Behaviors

In this section, origin trip, destination trip and driver’s route choice are showed by using road network data and GIS application. As shown in Figure 3, it can be seen that old suburban and inner city have the highest origin trip rate with 42% and 32% respectively. Outer city generates the moderate amount of trip and new Suburban have the lowest trip. In Figure 4, 75% of vehicular trips are heading toward the city center (CBD) area. Trips to the inner city is 25% of the total trip of northbound. As in Figure 4, Pyay Road, Kabaraye Pagoda Road, Shwegonedaing Road are mainly used to travel to CBD area. Within CBD area, the road user mainly use Shwedagon Pagoda Road, Bogyoke Aungsan Road and Maha Bandula Road.
Figure 3. Origin and Destination of Road User in Northbound Direction

Figure 4. Route choice of the Road User in Northbound Direction
In Eastbound direction, in Figure 5, inner city have 61% of originated trips, 10% from outer city, old suburban, CBD and new Suburban. 64% of trip are destined to inner city as townships in this city has high commercial and Residential Areas. New suburban and outer city has lowest trips from eastbound direction. As in Figure 6, Kabar Aye Padoga Road, Kanpet Road, Pyay Road and Baho Road are mostly used.

Figure 5. Origin and Destination of Road User in Eastbound Direction

Figure 6. Route Choice Road User in U Htaung BO Roundabout to U Wisara Roundabout Direction
According to the Fig7, Road user (73%) in southbound direction travel from the CBD area and 27% from inner city. They travel mostly the inner city as this city have high attraction places. Old suburban, outer city and inner city has same amount of destination trips. In Figure8, People mainly used Maha Bandula Road, shwegondaing Road, Kabaraye Pagoda Road.

Figure 7. Origin and Destination of road user in Southbound Direction

Figure 8. Route choice of the Road User in Southbound Direction
In Figure 9, Inner city produces 61% of origin trips where old suburban, outer city and new suburban produces small trips. 82% of trip are destined to inner city which is similar to the eastbound direction. Inner city has the highest trip rate and usage of road network especially to the townships like Bahan, Tarmwe and Mingalar Taung Nyut where wholesale market and office building are mostly located. In Figure 10, Most used roads are Kabar Aye Padoga Road, Kanpet Road ,Pyay Road ,Baho Road and Insein Road.

![Figure 9. Origin and Destination of Road User in Westbound Direction](image)

**U Wisara to U Htaung Bo Direction**

![Figure 10. Route choice of the Road User in Westbound Direction](image)
5.3 Trip Purpose

As shown in Figure 11, the main purpose of the trip using this route is for work trip with 65% of total trips while 26% were used for shopping and 9% for recreational purpose.

![Trip percentage by Purpose](image1)

Figure 11. Trip Purpose

5.4 Travel Distance

Travel distance travelled by the road users are shown in figure 12. They travelled at least 2.5km and up to 30km. This travel distance can be used in future re-assigning of route or new route planning figure 12.

![Surveyed Vehicle Travel Distance](image2)

Figure 12. Vehicle Travel Distance
6. CONCLUSION

This paper analyzes traffic congestion of the existing condition, route choice and origin-destination (O-D) of the daily traveler by interviewing where are they originated which routes they choice and their trip purpose and also include the use of GIS technology. It integrates the geodatabase, network analyst tool, and including base maps. Hence the work trip occupied most of the trips, there are more chances to use these routes by the daily commuter. And more chances for traffic congestion. Westbound direction have highest traffic volumes because they mainly connect the cities of high production and attraction places. Results obtained from calculating and analyzing of this study will be compared to the alternative improvement plans. This study could help the planners in important transportation like urban planning, re-assign road directions to mitigate congestion or providing of new route to access very high demand places.

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Identifying the Most Suitable Representation Method for Heterogeneous Time Series Data

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KEY WORDS: Time series, representation, performance evaluation, time series clustering

ABSTRACT: A time series data is a collection of measurements obtained sequentially, which is common in many application domains, e.g., fluctuations of stock market, observations from sensor networks, medical and biological signals. Since time series data usually contains large number of data points, i.e., high-dimensionality, directly dealing with such data in its raw format is very expensive in terms of processing and storage loading. To effectively and efficiently manage time series data, several representation methods were discussed. Representation methods can reduce the dimensionality of a time series data while preserving its fundamental characteristics. However, each method has its own drawbacks and is most suitable for certain time series data types, which means no single method is efficient enough for all possible types. To address this issue, this study aims at proposing a system that can identify the most suitable representation method for different types of time series. To be specific, this study first proposes a time series clustering approach to cluster sample time series datasets to identify different types of time series. We then conduct an extensive performance evaluation by testing the performance of different representation methods on the clustered time series types. Based on the evaluation, the most suitable representation methods for certain clusters can be identified. With a new time series input, the system can first classify this time series by computing its similarities with clustered time series types, which indirectly helps us identify the representation method that is the most suitable for this new time series data. Finally, evaluation result shows that there are three types of representations are the most suitable representation for different time series types respectively.

1. INTRODUCTION

1.1 Background

In recent years, time series data has been applied in different domains, such as environmental detection, healthcare, and smart life (Atzori et al., 2010). A time series is a collection of data obtained from sequential measurements over time. Formally, a time series $T$ is defined as a sequence of length $n$ pair, $T = [(p_1, t_1), (p_2, t_2) \ldots (p_n, t_n)]$ ($t_1 < t_2 < \ldots < t_i < \ldots < t_n$), where each $p_i$ is a data point in a d-dimensional space and each $t_i$ represents the point in time
when $p_i$ was measured (Esling and Agon, 2012). The nature of time series data includes (1) large data size, (2) high dimensionality, and (3) necessary to update continuously (Fu, 2011). As data continues to be produced over time, the rapidly increasing size of data brings higher demands for data storage, analysis and transmission. Therefore, directly dealing with such data in its raw format is very expensive in terms of processing and storage cost. To effectively and efficiently manage time series data, several representation methods were discussed (Wang et al., 2012). Representation methods can reduce the dimensionality of a time series, while preserving its fundamental characteristics (Esling and Agon, 2012). As shown in Figure 1., the main concept of time series representation is to reduce the size and dimension of the raw time series, but still preserve its fundamental characteristics.

![Figure 1. An example of time series representation](image)

1.2 Problem and Objective

While many time series representations have been proposed, different representations perform better than others on different types of time series (Wang et al., 2012). As time series data types are largely diverse, such as temperature, humidity, speed, vibration, pressure, we argue that no single representation is effectively enough to manage all types of time series data. Moreover, time series representations inevitably result in a certain degree of information loss. Striking a balance between information loss and compression rate is an important task. Therefore, the purpose of this study is to identify the representations for different time series data types that are the most suitable, i.e., high compression rate and low information loss. If the most suitable representation of a particular time series type can be identified, when a new time series is to be compressed, the time series is classified by calculating the similarity with the known time series, which indirectly helps us identify the most suitable representation for this time series.

2. RELATED WORK

2.1 Time Series Representation

As the size of time series data increases, the analysis and processing of time series becomes difficult to perform. Therefore, many existing work have proposed different time series representations to reduce the size of data, thereby reducing the execution time of the operation. Several representations that are currently applied to time series data
processing will be introduced as follows.

**Piecewise Aggregate Approximation (PAA) (Keogh et al., 2001):** The PAA method divides the time series data into several equal length segments. The number of segments is determined by the user, and the average value of the data in each segment is calculated and combined to form a new time series data. This method only needs to store the length of the segment and the average of each segment. The time complexity of PAA is $O(n)$. This method is very simple and intuitive, and the calculation speed is fast. An example of PAA representation is shown in Figure 2.

![Figure 2. An example of Piecewise Aggregate Approximation (PAA)](image)

**Adaptive Piecewise Constant Approximation (APCA) (Keogh et al., 2001):** The APCA method also calculates the average value of the data in each segment. However, the main difference between APCA and PAA is that APCA can adjust the length of each segment according to the time series. Longer segment length will be chosen for where the data fluctuation is small, and shorter segment length will be applied at where data has sudden changes. So that the output time series data can be more similar to the raw data. Compared to PAA, APCA’s disadvantage is that it requires more computing time and storage space to calculate the fluctuation of data and record the different segment lengths and averages of all segments. The time complexity of APCA is $O(n \log_2 n)$. An example of APCA representation is shown in Figure 3.

![Figure 3. An example of Adaptive Piecewise Constant Approximation (APCA)](image)

**Piecewise Linear Approximation (PLA) (Hung and Anh, 2008):** The PLA method divides the time series data into several equal-length segments, and the number of segments is determined by the user. Unlike PAA and APCA, PLA calculates the average and slope of each segment. Therefore, this method can achieve even higher similarity to the raw data. However, the main disadvantage is that PLA requires more storage space to record the slopes. The time complexity of PLA is $O(n)$. An example of PLA representation is shown in Figure 4.
Discrete Fourier Transformation (DFT) (Faloutsos et al., 1994): The DFT method decomposes the time series data into a finite number of sine and cosine waves, and each wave can be represented by a different Fourier coefficient. The raw data can be reconstructed by the waves with higher Fourier coefficients. The number of Fourier coefficients applied on data reconstruction affects the information loss and time spent. The time complexity of DFT is $O(n^2)$, but the time complexity can be reduced to $O(n \log_2 n)$ with the fast Fourier transformation. An example of DFT representation is shown in Figure 5.

Discrete Cosine Transformation (DCT) (Korn et al., 1997): The concept of the DCT method is similar to DFT. The main difference is that DCT decomposes time series data into a finite number of cosine waves. The time complexity of DCT is $O(n^2)$, but the time complexity can be reduced to $O(n \log_2 n)$ with the fast Fourier transformation. An example of DCT representation is shown in Figure 6.

Discrete Wavelet Transform (DWT) (Chan and Fu, 1999): The basic idea of the DWT method is to represent a time series with the summations and differences of different portions of the raw data. The first few coefficients contain an overall, coarse approximation of the data; addition coefficients can be imagined as "zooming-in" to portions for a more detailed view. An example of DWT based on the Haar wavelet is shown in Table 1.
Table 1. An example of Discrete Wavelet Transform (DWT)

<table>
<thead>
<tr>
<th>Level</th>
<th>Average coefficient</th>
<th>Wavelet coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>[7,5,3,3,3,4,6]</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>[6,4,3,5]</td>
<td>[1,1,0,-1]</td>
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<tr>
<td>1</td>
<td>[5,4]</td>
<td>[1,-1]</td>
</tr>
<tr>
<td>0</td>
<td>[4,5]</td>
<td>[0,5]</td>
</tr>
</tbody>
</table>

2.2 Time Series Distance Measure

There are different topics in the field of time series research, such as indexing of time series, clustering, classification, querying, etc. (Esling and Agon, 2012), where many of them requires the calculation of the distance between time series. The following two methods are widely used to calculate time series distances.

**Euclidean distance (Faloutsos et al., 1994):** The Euclidean distance measure is widely in many applications. Given two time series data, \( X=(x_1,x_2,x_3,\ldots,x_n) \), \( Y=(y_1,y_2,y_3,\ldots,y_n) \), the Euclidean distance between \( X \) and \( Y \) is defined as:

\[
D_{\text{is}}(X, Y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}
\]  

(1)

**Figure 7. An example of Euclidean distance**

**Dynamic time warping (DTW) (Keogh and Ratanamahatana, 2005):** Instead of the one-to-one point comparison in Euclidean distance, the DTW distance measure applies a one-to-many comparison between the data points in two time series. The main feature of this distance measure is that it can recognize similar shapes even with shifting and/or scaling differences.

**Figure 8. An example of Dynamic time warping**
3. METHODOLOGY

3.1 Data

This study has used the 85 time series data from UEA (University of East Anglia) & UCR (University of California, Riverside) Time Series Classification Repository. Prior to the summer of 2015 over 3000 researchers have downloaded this archive and it has been referenced several hundred times (Bagnall et al., 2017).

3.2 Clustering

As mentioned earlier, a time series data should be compressed with the most suitable representation method for low information loss and high compression rate. However, it is not feasible to identify the most suitable representation by directly compressing a new time series with all possible methods for every new time series data. Therefore, this research proposes an indirect solution that first clusters a set of sample data and identifies the most suitable representation for each cluster, and then by calculating distances between a new time series data with the clusters, the most suitable representation of the most similar cluster should also be the most suitable representation for the new time series data. In general, the main purpose of clustering is to group the time series data with the same trend into the same cluster. This research uses the DTW distance measure to find out time series data with the same trend as two time series could shift in the time domain or the scale is different. The pseudo code of clustering is shown as follows.

Algorithm 1 Clustering

**Input:** Array of time series datasets pair $P[i]$, array of $P$ distance $Dist$, threshold $T$

**Output:** Clusters include different time series datasets

1: Sorted $Dist$ in ascending order $Dist_1, \ldots, Dist_N$

2: **for each** distance $Dist_i$ of $Dist$ **do**

3:  **if** both of of $P[i]$ are in any cluster **then**

4:      **break**

5:  **else if** $Dist_i < T$ **then**

6:      **if** one of cluster contains one of $P[i]$ time series dataset **then**

7:          put another time series dataset in $P[i]$ into that cluster

8:      **else**

9:          create a new cluster and put two of time series datasets in $P[i]$ into new cluster

10: **end if**

11: **else**

12:      create two new clusters and put one of time series dataset into one cluster individually

13: **end if**

14: **end for**

15: **return** Clusters include different time series datasets
3.3 Performance Evaluation

After clustering, we apply 6 time series representations on clustered data. For each time series we use 4 data lengths (128, 256, 512, 1024) and five number of representation coefficients (2, 4, 8, 16, 32) to test the compression rate and information loss of different representations. The compression rate means the percentage of the data reduced by each representation, which ranges from 0 to 1, and the higher value means the higher compression rate. Information loss indicates the data loss after compression, i.e., the similarity between the compressed data and the raw data. The similarity between time series data can be estimated by the Euclidean distance measures, where a shorter distance represents higher similarity. The most suitable representation for a time series data is identified for that it achieves high compression rate and low information loss.

4. RESULTS

4.1 Clustering Result

In this study, 85 time series data were grouped into 21 clusters. The results are shown in Table 2.

<table>
<thead>
<tr>
<th>Cluster number</th>
<th>Number of time series</th>
<th>Cluster number</th>
<th>Number of time series</th>
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<tr>
<td>#1</td>
<td>6</td>
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<tr>
<td>#21</td>
<td>1</td>
<td></td>
<td>Total: 85 time series data</td>
</tr>
</tbody>
</table>

4.2 Evaluation Result

Compression rate: As the compression rates of each time series on different representations are similar, Figure 9 shows one of the results as an example. As the size of raw data increases, the compression rate increases. If more representation coefficients are used, the lower the compression rate. In general, when PLA uses more parameters, the compression efficiency is significantly lower than other representations. While PAA, APCA, DCT and DFT apply similar numbers of compression efficiencies, their compression rates are similar, which is about 0.4 to 0.96.
Information Loss: The information loss is based on the distance calculation, where smaller values mean higher similarity between time series data. We took the average of distances from the same cluster obtained by each time series representation. In the current research, a time series representation that can produce the smallest average distance is the most suitable representation for the cluster. The reason is that, while compression rates are usually similar between difference representations, choosing a representation that can achieve lower information loss is a logic design. The results are shown in Table 3.

Table 3. The most suitable representation for each cluster

<table>
<thead>
<tr>
<th>Cluster Number</th>
<th>Most Suitable Representation</th>
<th>Cluster Number</th>
<th>Most Suitable Representation</th>
</tr>
</thead>
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<td>DFT</td>
</tr>
<tr>
<td>#11</td>
<td>APCA</td>
<td>#12</td>
<td>APCA</td>
</tr>
<tr>
<td>#13</td>
<td>PLA</td>
<td>#14</td>
<td>APCA</td>
</tr>
<tr>
<td>#15</td>
<td>DFT</td>
<td>#16</td>
<td>DFT</td>
</tr>
<tr>
<td>#17</td>
<td>APCA</td>
<td>#18</td>
<td>APCA</td>
</tr>
<tr>
<td>#19</td>
<td>APCA</td>
<td>#20</td>
<td>APCA</td>
</tr>
<tr>
<td>#21</td>
<td>PLA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the selected representations, we have observed that for time series data with periodical changes in a stable frequency, the most suitable time series representation is DFT, such as the cluster number 1 (Figure 10). For time series data that have irregular and sudden fluctuation, APCA is the most suitable representation, such as the cluster number 20 (Figure 11). If time series data have monotonous trends, PLA is selected as the most suitable representation, such as the cluster number 9 (Figure 12).
Figure 10. The time series data of the cluster number 1

Figure 11. The time series data of the cluster number 20

Figure 12. The time series data of the cluster number 9
5. CONCLUSIONS AND FUTURE WORK

Many time series representations have been proposed to address the high dimensionality issues. However, as no single representation performs the best for all types of time series data, this study aims at proposing a system that can adaptively choose the most suitable representation for every time series data. With the proposed time series data clustering analysis, we can cluster similar types of time series data together and identify the most suitable time series representation for each cluster. The evaluation results show that the same type of time series data does have a suitable time series representation. For time series data with periodical changes in a stable frequency, the most suitable time series representation is DFT. For time series data that have irregular and sudden fluctuation, APCA is the most suitable representation. If time series data have monotonous trends, PLA is selected as the most suitable representation.

In the future, more time series representations will be included, such as the Symbolic Aggregate approximation (SAX) and the Discrete Chebyshev Transform (DChT). Based on the evaluation, the most suitable representation methods for certain time series types can be identified and will be applied to a time series data management system.

REFERENCE

Analysis of the Spatial Reasoning of Historical Perak Sultanate

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Abstract: The pattern of buildings location can reflect the identity of the historical buildings to the social relations. The aim of this research is to elucidate the spatial relationship of the historical Sultanate of Perak physical features with the orientation and distance with the other historical buildings in a discrete spatial scales. The objective of this paper is to analyse the spatial orientation and distance between all features and to identify the relationship between the palace and locations’ analysed. Using this notation, the interaction between space and distances are derived to understand the reasoning such location of the historical features. The findings show that i) Istana Iskandariah are located at the hill top ii) most of Rumah Pembesar are facing to the Istana Iskandariah, iii) a linear pattern due to the relocation of palace was during Colonial, iv) Islam are the main connection between palace and people.

Keywords: distance, GIS, historical, orientation, Perak Sultanate.

Historical Background

The characteristics of the historical movement and interaction of people however is difficult to be done. Thus, the historical and cultural studies on people’s perceptions of the sites importance and spatial arrangements, together with the interpretations, give an essential for a deeper understanding of cities (Rau, 2014). The aim of this paper is to understand the underlying reason on the relationship of the pattern of physical context are related to the historical Perak Sultanate era. Royal towns have high historical and cultural values that are worthy of preservation (Harun, Fairuz, & Nordin, 2015). The Malay traditional town includes palace, mosque, market, river and settlements.

This study tries to understand the Malay Royal town, particularly in Kuala Kangsar, Perak in term of location of the important historic buildings. The attributes that will be collected
such as royal palace complexes, fortress, gateway, mosque, public open spaces, marketplace, river and also the settlements. Perak is the second oldest Sultanate in the Malay Peninsula (Kim, 2015). The historical of Perak Sultanate is begins in 1528 with the installation of Sultan Muzzaffar Syah I, the son of Sultan Mahmud Syah was brought to Perak from Melaka after Portuguese conquered Melaka in 1511. The Sultan, son of the last king of Malacca, was "invited" by the chiefs along the Perak River to reign over Perak, shortly after 1511 when Malacca fell to the Portuguese. He resided at Tanah Abang, and ruled Perak for approximately 21 years. At least 15 location of administration centres are changed from time to time due to the changes of Sultan, and mostly the location at the riverine areas. The actual palace was Istana Seri Sayong that was built in the Lembah Sayong that is located at the intersection of the two rivers. But due to its location in a lowland area, the royal official residence was always subjected to floods during the monsoon season. Thus, the sultan decided to relocate the palace to Bukit Chandan. The location of the palace on the left bank of Sungai Perak upstream from Hilir Perak. The name Bukit Chandan was taken after the name of an elephant to Sultan Yusuf Sharifuddin Mudzaffar Shah (Sultan of the 27th Sultan) who ruled the state of Perak for 10 months.

According to the story, it was said that one day, the elephant, Kulup Chandan had run away from Sultan Idris (back then as the Young King) and he tried to find the elephant until arrived at the foot of Mount Bubu. He met with a long bearded old man wearing a white robe, and the old man said ‘You are going to be the Sultan of Perak. Once you crowned as Sultan, please do not stay in Sayong again and build a palace on the hill on the edge of Batang Hari, Perak. The elephant should be free in 7 days after your coronation’ (Fawzi Basri, 2016).

The palace at Bukit Chandan are built at 1885, known as Istana Negara are located at the left side of the river banks of Sungai Perak (Fawzi Basri, 2016). This palace is built during the reign of Sultan Idris Mursyidul Azam Syah, Perak 28th Sultanate (1887 - 1916). However, this palace was demolished and it was replaced to Istana Iskandariah that was built in 1932.

Using Spatial Reasoning in Historical Analysis

The integration of geographical referenced information into conceptual frameworks and applied uses of the social sciences and humanities has been ongoing process over the past few centuries, including analysis on spatial relationship. Spatial reasoning analysis extensively use in large scale spaces, it differentiate several spatial relations and its typically formalize using a Cartesian coordinate system and vector algebra (Frank 1996). In this case, the use of spatial reasoning in historical analysis give a new perspective on how to analyse the historical study effectively by measure physical arrangements and clustering of phenomena to identify spatial patterns, document spatial patterns over time to infer processes, study flows (e.g., migration, trade, & shopping patterns) between specific locations as indicators of spatio-temporal interactions. The information processes is clearly different from the ways human draw conclusion about spatial
relations. Therefore, the objectives of this paper are; i) to analyse the spatial orientation and distance between all features obtained from the map and ii) to identify the relationship between the palace and locations’ analysed.

**Study area**

The study area is in Bukit Chandan, Kuala Kangsar, Perak. This area, Bukit Chandan is where the official palace of the 28th Perak Sultanate until today. Since over 130 years, many changes have happened in Bukit Chandan. It has been through the rule of eight sultans and witnessed important events, including the coronation of sultan, royal weddings, ceremonies and official visits from abroad, principals and religious teachers. Fig.1 shows the land use overlay to the buildings.

![Figure 1: Location of Kg. Bukit Chandan in Kuala Kangsar (Rancangan Tempatan Daerah Kuala Kangsar 2020, 2012).](image)

Several palaces and mansions have been set up for residences purpose. Some of them have already burned by fire, some are still standing and becoming tourist attractions, while others are waiting for the collapse. Thus, this research tried to understand is there any spatial relationship between the palaces, mosques and the *Rumah Pembesar*. It was also hypotheses that the orientation of front features are facing to kiblah. This is due to the importance of Islamic influence in the Sultanate rule. Thus, it is important to understand the reason of placement of the features analysed.
Buildings

Several buildings has been identified as old buildings in which the owner of such buildings give a significant contribution to the Sultan. Several palaces are no longer exist, and some of them are maintained until now. Below are all buildings (Table 1) that was considered in this research as long as all information of the building location can be derived.

Table 1: Buildings used for the research

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Year Build</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Istana Lembah Palace</td>
<td>1926</td>
<td>Now Istana Kenangan</td>
<td></td>
</tr>
<tr>
<td>Istana Ulu Palace</td>
<td>1903</td>
<td>Now Galeri Sultan Azlan Shah</td>
<td></td>
</tr>
<tr>
<td>Istana Nagara Palace</td>
<td>1895</td>
<td>Burned and replaced to Istana Iskandariah</td>
<td></td>
</tr>
<tr>
<td>Istana Baitul Rahmah</td>
<td>Malay Noble Residence 1911</td>
<td>House of Raja Harun Ar-Rasyid but leave it as it.</td>
<td></td>
</tr>
<tr>
<td>Masjid Ubudiah Mosque</td>
<td>1914</td>
<td>Maintain until now</td>
<td></td>
</tr>
<tr>
<td>Baitul Anor Malay Noble Residence 1912</td>
<td>Raja Kecil Sulung Perak Raja Harun Al-Rashid for wife, currently used as Gallery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Madrasah Idrisiah Mosque 1922</td>
<td>Play a role as an Islamic School</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Madrasah Muhamadiah Mosque 1888</td>
<td>A mosque since earlier time until now</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rumah Merah Rumah Pembesar 1903</td>
<td>Remain as it is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rumah Meor Rumah Pembesar 1903</td>
<td>Remain as it is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rumah Hitam Rumah Pembesar 1903</td>
<td>Remain as it is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rumah Tuan Haji Wok Rumah Pembesar</td>
<td>Remain as it is</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Methodology

Field visits were conducted at Bukit Chandan, Kuala Kangsar, Perak as this area was gazetted as a Malay Royal town. From the fieldwork, the researcher had mapped all the existing historical buildings that still exist in the study area to develop a deeper understanding of the Malay Royal. Semi-structured interview method was also used for data collection in order to understand the historical context of Kuala Kangsar. The location and orientation of the houses from the palaces, mosques and other historical buildings were analysed. The spatial reasoning approach in this study has been conducted to understand how the features are placed according to space and spatial situations are described and explained.
Analysis and Results

This analysis will answer the first objective, that is to analyse the spatial orientation and distance between all features and to identify the relationship between the palace and locations’ analysed Datasets of the palaces, the sultan relative houses and mosques were inserted in the analysis. The map (Fig. 3) shows that the spatial urban structure of royal town Kuala Kangsar are parallel with the direction of the riverine areas.

Figure 3: Orientation of the analysed buildings
A palace complex, Istana Iskandariah located at the top of the natural hill to catch the prevailing wind. The palaces were built at the areas of wide open spaces or squares. The palace entrance are also facing at the West, as where the kiblah, as a direction toward the Muslim prays, symbolised of faith in the Oneness of Allah. Even Istana Kenangan also facing to the kiblah. The map also shows the orientation of five (5) Rumah Pembesar (except Baitul Anor and Rumah Meor) were directly towards Istana Iskandariah, which shows a loyalty and respect of the people to the Sultanate.

The map also clearly seen that the Masjid Ubudiah and Madrasah Idrisiah are the main centre of the linkage of the houses and also the palace. Madrasah Idrisiah is an Islamic educational point that is facing Masjid Ubudiah. This results shows that the Islamic elements are the focal point of this royal town. In addition, only Baitul Anor facing the main road, and Rumah Meor facing to the mosque (Masjid Ubudiah), mainly due to these houses are located nearby to the mosque. This can be conclude that the nearer the mosque, the settlement and public open space character is different, that explained the reason of Baitul Anor and Rumah Meor is not orientated to the palace.

Interview has been conducted to the people in Kuala Kangsar and explained that the old settlement and the mosque are located along the river, as the river acted like a warning relay line in case of attack, which is explained in Fig. 4, which is designed text documents. It is also mentioned by Swettenham, (1893) that the people are easily looks out on the river, shows that the settlement are close to the river. However, the current settlement are located around the houses of the Pembesar, and some parts are at the fringe of the river. Fig 4 also show that in front of the Istana Iskandariah is the public open spaces, which is the assembly place for both of the rakyat and Sultan. However, the information of distance and orientation of the old settlement to the palace are unable to be done in the map (Fig. 3) as it was disappear.

There are authors that claimed that palaces in the older Malay towns were surrounded by villages as the commoners lived surrounding the royal families and influential leaders (Daud, Arbi, & Faisal, 2012). However, this study area has a different royal structure as mentioned previously, where the mosques was a linkage between the palaces and the settlement areas. Back then, the decision of selecting Bukit Chandan as the palace spaces as the relocation are done during the Colonial, a reason of the Royal town of Kuala Kangsar is linear, instead as following the pattern of older Malay towns. The interference of the Residence is not normal and this reflected to the pattern of urban settlement (Fig. 4).

The palace has huge abundant of trees and open spaces, squares and parks surrounded the palace. The undulating areas that separate the palace, religion hub and the settlements areas. The valley is the main settlement areas and the hilly areas as the cultivation and open spaces area. It was also claimed that behind of these village there is a rice field, easily irrigated and annually enriched by the overflow of the great river while on the either side, a range of hills shuts in the valley (Swettenham, 1893). Table 2 shows the distance and orientation to Istana Iskandariah.
Table 2: Distance and orientation to Istana Iskandariah

<table>
<thead>
<tr>
<th>No</th>
<th>Houses</th>
<th>Distance</th>
<th>Orientation</th>
<th>Direction from Istana</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Istana Iskandariah</td>
<td>-</td>
<td>West</td>
<td>Facing Kiblah</td>
</tr>
<tr>
<td>2</td>
<td>Istana Kenangan</td>
<td>100 meter</td>
<td>West</td>
<td>Facing Kiblah</td>
</tr>
<tr>
<td>2</td>
<td>Istana Ulu</td>
<td>1 km</td>
<td>South East</td>
<td>Facing Istana Iskandariah</td>
</tr>
<tr>
<td>3</td>
<td>Baitul Rahmah</td>
<td>250 meter</td>
<td>South East</td>
<td>Facing Istana Iskandariah</td>
</tr>
<tr>
<td>4</td>
<td>Masjid Ubudiah</td>
<td>650 meter</td>
<td>West</td>
<td>Facing Kiblah</td>
</tr>
<tr>
<td>5</td>
<td>Baitul Anor</td>
<td>500 meter</td>
<td>South West</td>
<td>Facing the main road</td>
</tr>
<tr>
<td>6</td>
<td>Madrasah Idrisiah</td>
<td>650 meter</td>
<td>North East</td>
<td>Facing Masjid Ubudiah</td>
</tr>
<tr>
<td>7</td>
<td>Madrasah Muhamadiyah</td>
<td>750 meter</td>
<td>South West</td>
<td>Facing the main road</td>
</tr>
<tr>
<td>8</td>
<td>Rumah Merah</td>
<td>1.2 km</td>
<td>South East</td>
<td>Facing Istana Iskandariah</td>
</tr>
<tr>
<td>9</td>
<td>Rumah Meor</td>
<td>600 meter</td>
<td>South East</td>
<td>Facing Masjid Ubudiah</td>
</tr>
<tr>
<td>10</td>
<td>Rumah Tuan Haji Wok</td>
<td>1.1 km</td>
<td>South East</td>
<td>Facing Istana Iskandariah</td>
</tr>
<tr>
<td>11</td>
<td>Rumah Hitam</td>
<td>1.5 km</td>
<td>South East</td>
<td>Facing Istana Iskandariah</td>
</tr>
</tbody>
</table>

Istana Kenangan is located at the west of Istana Iskandariah and the closest (100 meters). Both palace are facing kiblah. However, Istana Ulu, Baitul Rahmah, Rumah Merah, Rumah Meor, Rumah Tuan Haji Wok and Rumah Hitam are facing Istana Iskandariah at the south east, Madrasah Idrisiah are facing the Masjid Ubudiah. This analysis show that Rumah Merah, Rumah Tuan Haji Wok and Rumah Hitam are facing Istana Iskandariah. However, it was noted that it can be other Rumah Pembesar old houses during early times but it was unable to be used for analysis due the house is not exist anymore and it is difficult to estimate the orientation.

**Conclusion**

The royal town in Kuala Kangsar are linear pattern following the riverine areas. Islamic centre, Masjid Ubudiah was a linkage between the palaces and the settlement areas. Islam are the main connection between palace and people. Many of the Rumah Pembesar are facing the palace, and this indicating a high respect from them to the Sultan. The land cover includes Sultanate place, residential (settlement), market (commercial), masjid (Islamic religion) and Madrasah Idrisiah (education). The pattern also shows that the nearer the mosque, the settlement and public open space character is different.
Acknowledgment

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References


DEVELOPMENT OF PANCHYAT RESOURCE INFORMATION SYSTEM IN HIMACHAL PRADESH USING GEO-INFORMATICS

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Key words: Panchyat, spatial, GIS, remote sensing

ABSTRACT

The process and practice of planning are getting decentralized to lower area units to make them area specific and responsive to needs of local people. The XIth five year plan (2007-12) lays emphasizes on drawing up of development plans by grass root Institutions, capacity building of these institutions and requirement of sharing developmental information with the beneficiaries. The Gram Panchayat is the foundation of the Panchayat System and it is extremely important to empower Gram Panchayat in terms of resource database creation and use of the same for better future. The present day planning is mainly dependent on the non-spatial and secondary information. Spatial information of the available resources is a pre-requisite for developing grass root level developmental plans, attaining the goals and for the time bound completion of the developmental-plans. A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of spatial information about natural resources and infrastructure development. Geospatial Resource Information System is designed for the identification and mapping of the local resources spatially and understanding the problems and potentialities of each resource. It provides the basic details in GIS format which serves as a base for planning the development activities of the Departments like Planning, Agriculture, Soil Survey, Soil Conservation, Irrigation, Ground water, Rural Development etc. Geospatial plan helps in upkeep of existing infrastructure, identifying gaps in the existing facilities and planning establishment of an asset based on geo-spatial analysis of various variables including terrain, topography, action plan generation for rural development works, check duplicity of works, measure and monitor distribution of beneficiaries and regional and sub-regional imbalances.

1. INTRODUCTION

Recent technological advances in domain of spatial technology are making considerable impact in planning related activities. Timely and reliable information on cost effective manner in spatial and temporal domain, which can act as a reliable base line information on natural resources at scale ranging from regional to micro levels, can be generated by Geographic Information System (GIS), which can help for integrated analysis of natural resources inventory, management and planning the strategy for sustainable development and stand as a power effective administrative and management tool for decision making. The GIS provides an added dimension to data analysis which brings us one step closer to visualizing the complex patterns and relationships that characterize real-world planning and policy problems. (Ambasta, 2010; Asadi et al., 2011 Manikkumaran, 1997; Mukherjee, 2011; Scaria and Vijayan 2012; Jain K and Subbaiah, 2007). In the view of above, a project was undertaken to develop Panchayat Resource Information System of Malyanna, Chamyana & Pujarli Panchayat of Mashobra Block of Shimla District of Himachal Pradesh using geo-informatics.

2. MATERIALS & METHODOLOGY

2.1 Study Area

The Three Panchayats selected for the present study named Chamyanna, Malyanna and Pujarali lie in the Mashobra block of Shimla district and are adjoining to the Shimla Urban Area. The Shimla District lies between 30°45” to 31°44”N Latitude and 77°0” to 78°19”E Longitude. It has geographical area of 5131 sq. km (Balokhra, 2005: Jeart, 2005).
2.2 Data Used

The details of various spatial and non-spatial data used in this study area are given below:

2.2.1 Remote Sensing Data

Cartosat - I images are the basic remote sensing data which has been used for mapping the Panchayats.

2.2.2 Ancillary/Collateral Data

Administrative boundary of State, District, Block and Panchayat, Panchayat Asset Registers

2.2.3 Ground Truth Data

The location of various natural and manmade resources was determined with the help of Maps and Global Positioning System.

2.2.4 Mapping & Creation of Geo-database

Field Survey: The Ground Control Points (GCPs) were taken using GPS Mobile (Samsung Wave 525)

Geo-Referencing: The satellite data was geo-referenced in Arc GIS

Layer Creation: The following raster and vector layers were created in Arc GIS

- Land use/Land Cover
- Digital Elevation Model,
- Drainage,
- Roads
- Water Tanks
- Educational Facilities,
- Medical Facilities
- Veterinary Institutions
- Anganwaris
- Other Socio-economic structures

Map Creation:- The map outlay was created in Arc GIS

3. RESULTS & DISCUSSION

3.1 Natural Resources

3.1.1 Land use/Land cover & Digital Elevation Model

The total sprawl of the study area covering three panchayats is 32.07 sq. km. Approximately 14.37 sq. km, 3.63 sq. km., 12.65 sq. km. and 1.42 sq. km area falls under forest, agriculture and grassland and settlements respectively.
The catchment area of the Chamyanna Panchayat, Sargheen, Goasn and Beolia Villages of Pujarali Panchayat and the Malyanna village of the Malyanna Panchayat are extensively covered by the rich forests. Vegetables are mainly grown on agriculture area in all the three Panchayats (Figure 2).

The elevation in the study area ranges between 1238-2601m in the study area (Figure 3).

3.1.2 Drainage & Hydrology

There are three main streams in the study area. All these meet at a point called ‘Dogla Nala’. These carry excess rain water from hills in the rainy season. Physiography of the three panchayats separates these from each other and meets near the Sadhupul and Dogla Nala.

Figure 5 represents the hydrological system of the study area and includes drainages, water tanks, tubewells, bawadies and hand pumps. Water tanks are mainly constructed under the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) scheme. Bawadies are mainly used for drinking water.

3.2 Infrastructure

3.2.1 Medical Institutions & Veterinary Institutions

The primary health centres are the only medical institution in the study area. They provide the basic medical facilities and other medical aids to the villagers. Figure 6 depicts the location of health centres in the study area. The Chamyanna panchyat has one Primary Health centres while pujarali panchyat has one primary health centre and one Ayurvedic Health Centres providing the basic medical facilities to the population.
There are four Veterinary Institutions in the study area. Two veterinary dispensaries are located in the Pujarali panchayat at Dhamechi and Sargheen village, whereas one veterinary institute is located at Chamyanna and Malyanna Panchayat each (Figure 7).

3.2.3 Educational Institutions

The study revealed that there are five Govt. Primary Schools, one Govt. Middle School and one Govt. Senior Secondary School in the Chamyanna Panchayat and five Govt. Primary Schools and one govt. senior secondary school in the Pujarali Panchayat (Figure 8).

The study revealed that there are four anganwari centres in the Chamyanna panchayat and two anganwari centres in the Pujarali panchayat (Figure 9).

3.3 Assets Created Under Various Schemes

The spirit of India lives in villages and only by changing the face of rural areas, there will be better future for the State and nation as a whole. The Rural Development Department is engaged in changing the face of rural Himachal through its many fold development schemes, working in a participatory manner with the rural folks. (Report of National Bank for Agriculture and Rural Development (NABARD), HP, 2009; Annual report of planning department Government of Himachal Pradesh, 2008; Annual Report., 2011; India Infrastructure Report, 2007; Report on Total Sanitation Campaign (TSC) in Himachal Pradesh, 2011).

3.3.1 Pradhan Mantri Gram Sadak Yojna (PMGSY): Rural roads

Pradhan Mantri Gram Sadak Yojna (PMGSY) is a centrally sponsored scheme with the primary objective of providing connectivity by way of an all-weather road to the eligible and un-connected habitations in the rural area. The study shows that all the villages are connected through the pedestrian ways. The pedestrian ways are constructed under the MNREGA Scheme (Figure 10 and Figure 11).
3.3.2 Indira Awas Yojana/ Indira Awas Yojana: Rural Housing

Indira Awas Yojana (IAY) is a Centrally Sponsored Scheme. Under this Scheme, assistance of Rs. 38,500/- per beneficiary is being provided to to Rural Below Poverty Line (BPL) families for the construction of new houses upto 31-3-2010. Atal Awas Yojana (AAY) is a State sponsored scheme aimed at provide housing facility to Rural BPL houseless families.

Figure 12 shows that four houses are built under Awas yojna in Chamyanna panchyat as compared to one in Pujarali panchyat.

Figure 12 Distribution of Awas Yojna schemes, Aanganwadi Centres, Community Centres, Cremation Centre and Gram Hut.

Figure 13 House of Sh.Puran Chand S/O Sh. Chet Ram (Beneficiary) Vill.Kalhali, Chamyana

The Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) notified on 7th September, 2005, aims at better livelihood security of households in rural areas of the country by providing at least one hundred days of guaranteed wage employment, in a financial year, to every household whose adult members volunteer to do unskilled manual work permissible under MGNREGA.

The water tanks are mainly those spatial features in the study area which are constructed through different programmes like MGNREGA, Irrigation & Public Health Department (IPH), Panchayat and other funding agencies. Vegetables are mainly grown with the help of these water tanks. The construction of water tanks have benefited the villagers in two ways by providing the employment to the villagers under MGNREGA programme and by growing vegetables with the help of the storing water in these tanks for irrigation of the vegetables.

Figure 13 & 14 shows the spatial distribution of water tanks in study area. There are 28 water tanks constructed in Pujarali panchyat as compared to 22 in Chamyanna panchyat. There are 5 water tanks in Malyanna panchyat.

Figure 14 Distribution of water tanks  

Figure 15 Comparison of establishment of water tanks

Figure16 Water Tank (Irrigation) Under MNREGA Scheme Beneficiary: Ishwar Chand s/o Late Sh. Kanshi Ram, Vill. Dhamechi (Sanctioned Amount Rs.50000/- Location N 31° 02’ 46.5” E 77° 10’ 25.3” Alt. 1504m)
3.3.4 Total Sanitation Campaign (TSC): Rural Sanitation

The main objectives of Total Sanitation Campaign (TSC) is to accelerate sanitation coverage, cover all schools and anganwadis with sanitation facilities and promote hygiene behaviour among students and teachers, encourage cost effective and appropriate technology development and application, and endeavour to reduce water and sanitation related diseases in the study area.

Figure 17 show the spatial distribution of sanitation facilities under the TSC programs. Six new toilets in Chamyanna panchyat and 4 new toilets have been built in Pujarali panchyat under TSC programme. However, there is only one garbage collection centre for three panchyats housed at chamyanna panchyat.

![Figure 17 Distribution of Garbage Collection Centre, Toilets, Land Development, Check Dams, Sanitary Works.](image)

7.5 Development of Common Property Resources (CPR) under various schemes

The other schemes include construction of Rain Shelters, Protection/Retaining Wall, Poly Houses, Garbage Collection Centre, Toilets, Land Development, Check Dams, Sanitary Works & Khel Maidan.

![Figure 18 Distribution of Poly houses, Rain shelter, Protection Wall and Khel Maidan](image)

CONCLUSIONS
- The study area covering Chamyanna, Malyanna and Pujarali panchyats presents entirely mountainous and valley shaped topography. The highest proportion of land is contributed to forest only. Although
the study area is dominated by agricultural activities but the agriculture yield is low which can be attributed to hilly terrain and small size of land holding and insufficient irrigation facilities

- In context of overall development and implementation of various development schemes, the Pujarali Panchayat takes lead followed by Chamyanna panchyat. However Malyanna panchyat is least developed in terms of socio-economic infrastructure/implementation of rural development schemes.

- The Panchayat Resource Information System developed for three Panchayats of Shimla district depicts status of land use, water resources, socio-economic facilities created under various government schemes. This information can be used by planners and administrators for

  - Updating Data bank
  - Generating Action Plans
  - Calculating Budget Estimates
  - Planning of micro drinking water schemes
  - Planning of irrigation schemes
  - Development of watershed programmes
  - Extension of road network
  - Visualizing developed and less developed pockets and thereof establishing of new educational, health and other facilities in less privileged pocket.
  - Monitoring of various projects & schemes
  - Impact assessment of schemes
  - Identification and utilization of ponds for pisci-culture
  - Identification of cultural heritage spots/homestay for tourism

REFERENCES


