Sponsored Thesis Project Competition on

"RE-IMAGINING URBAN RIVERS"

Season- 2

Project Title: METAMORPHOSIS – Ecological Restoration and Development of an abandoned quarry, a case of ARAI Stone Quarry, Pune

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ACKNOWLEGEMENTS

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Date: 27.05.2022

Place: Pune

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ABSTRACT

A quarry is an area from which rocks such as marble, limestone, and granite are extracted for industrial use. Once depleted of their desired resources, quarries are frequently abandoned. The resulting gaping holes can fill with water and form dangerous quarry lakes while others are turned into unsightly landfills. This paper discusses a case of the Vetal tekdi stone quarry (ARAI) which is an example of the adaptive reuse of an abandoned stone quarry. The research was conducted for understanding the positive and negative experiences faced by the people who regularly visit ARAI. This study examined the various challenges faced by the visitors, the facilities that were lacking according to them and the possible interventions that will enhance the experiences for the visitors. A quantitative and qualitative research methodology was adopted. A google form survey method was employed to get insights from respondents from Pune city. The experiences, challenges and the opinions shared by the respondents were highlighting the various issues faced at ARAI considering the parameters of safety and security, vandalism, ambience, cleanliness and ease of way- finding. The findings of the study can be applied to develop the nature trail along ARAI stone quarry and in turn setting an example for the adaptive reuse of abandoned stone quarries.

Metamorphosis is change of physical form, structure, or substance. A quarry after it is exhausted of its material content, traditionally is then abandoned by the owners and it leaves anthropogenic scars on the land and the ecosystem around it.

The objective of this thesis is to encourage the metamorphosis of an abandoned stone quarry and the nature trail around it into a biodiversity park.

KEY WORDS - Reclamation of Abandoned stone quarries, interventions, Vetal Tekdi, Pune city, Bio Diversity park, adaptive reuse.

1.0 INTRODUCTION

A quarry is an area from which rocks such as marble, limestone, and granite are extracted for industrial use. Once depleted of their desired resources, quarries are frequently abandoned. The resulting gaping holes can fill with water and form dangerous quarry lakes while others are turned into unsightly landfills. When quarries are in close proximity to urban environments, inhabitants are subjected to pollution and noise, and the undeniable eyesore of an abandoned quarry remains long after excavation is completed. Sustainable redevelopment has become a shining solution for these abandoned, resource-depleted quarries. Redeveloping these quarries will enhance the socio-cultural and economical values of the place where the quarry is located. In this research paper, a case of ARAI in this respect is studied.

2.0 BACKGROUND

Vetal Hill (ARAI) is a part of Bhamburda Van Vihar located on the western side of Pune Municipal Corporation within the city limits. Vetal Tekdi is prominent and is visible from Pashan, Panchavati, Chatturshrungi and other parts of the city. It has two spurs, Fergusson College Hill and Chatturshrungi Hill. There is one access road leading up the hill from the south. This can be used to access the Automotive Research Association of India campus located on the hill. There is a public parking lot also located along this road, however access is restricted to this between 8:30 am and 5:30 pm.

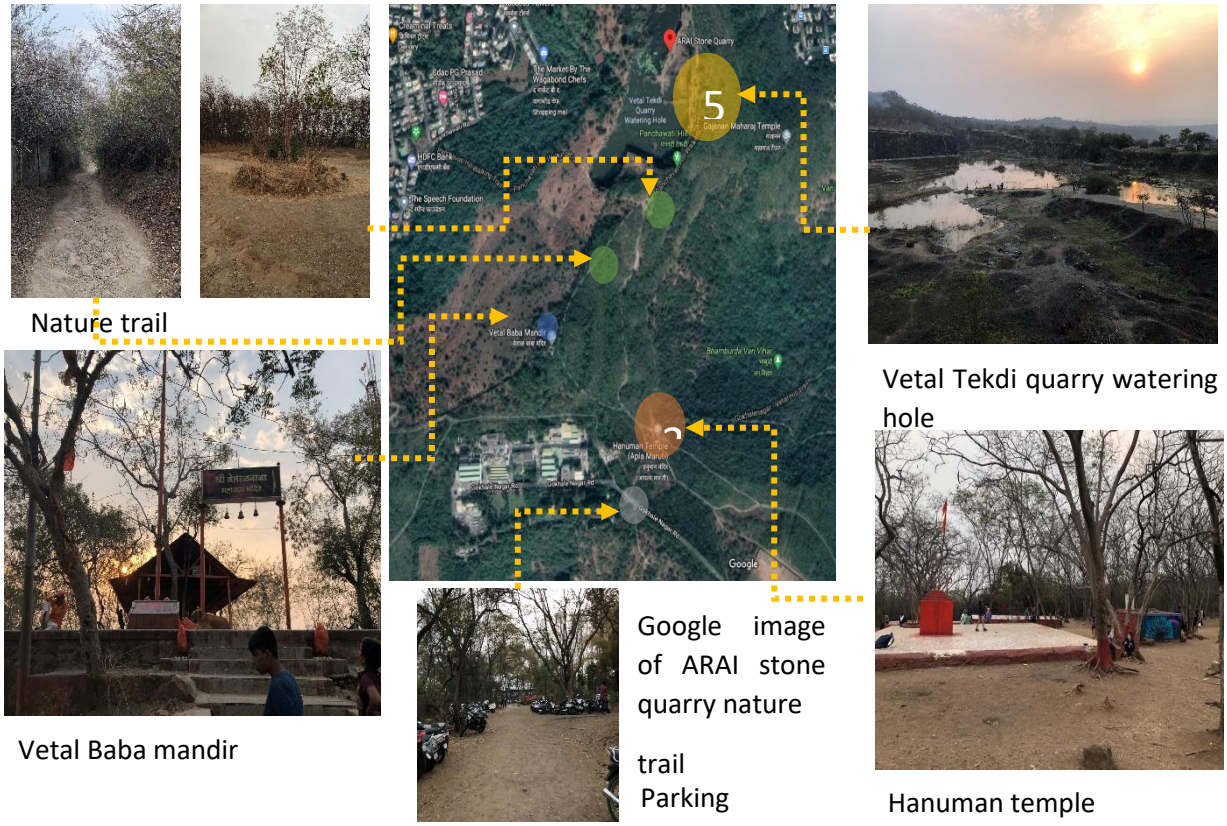


Fig 1 – Google image of ARAI stone quarry with different spots

Fact file:

Vetal Hill, Pune

Reservation: Forest

Type of forest: The natural dry vegetation has a dry deciduous nature, without tall trees and with medium sized trees and shrubs.

Rock type: Basalt

Site area: 5.9 Ha

Depth of the quarry hole: 12 mts.

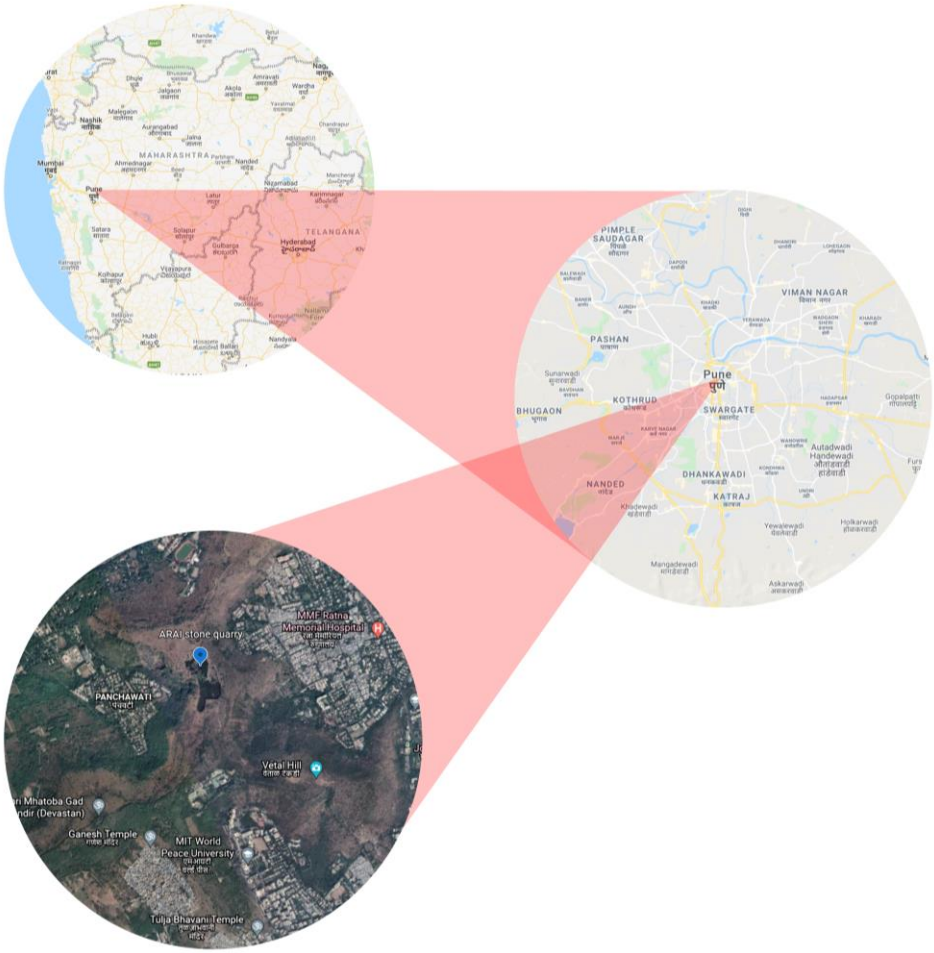


Fig 2 - ARAI Stone Quarry Watering Hole

Source – Google Earth

Fig 3 - ARAI Stone Quarry Watering Hole

over the years

Source – Google Earth

3.0 LITERATURE REVIEW

3.1 SYNOPSIS OF ALLIED RESEARCH PAPERS

The research papers have been written on the basis of various case studies of the existing quarries and their condition as of now. The case studies are from various parts of the globe and the way people perceive these as natural landscapes is also recorded. In one of the studies papers, a multi-criteria decision analysis approach was applied and 'do nothing' about the quarries was the least appropriate response.

The paper, 'Quarries: From Abandoned to Renewed Places' written by Katia Talento , Miguel Amado and Josè Carlos Kullberg talk about an innovative matrix of schemes to classify the existing fundamental methods of recovery. For this effect, the investigation was proposed to be an instrument to improve the knowledge in the scientific and theoretical sectors, flanking the practical understanding. The key question discussed in the paper is – 'Will it be possible to

investigate and derive new methods of rehabilitation starting from this matrix of schemes?' The paper also discusses a brief history of the notion of quarry reuse and the new valve of industrial landscape. (Katia Talento, 2020)

Another paper, 'No longer just a hole in the ground' written by Catherine McCandless tries to encourage the rehabilitation of land disturbed by quarrying by making the areas suitable for new sustainable land uses. The author has examined cases that successfully transformed resource-depleted quarries into commercial and residential communities, and discussed how further to improve future redevelopment of quarries with greater consideration to environmental impact and biodiversity. The paper also discusses case studies to include each serve as examples of different methods that the successful adaptive re-use of quarries can follow. The five cases are each located in a different geographic location—three in the United States and two abroad—and vary in the time in which the projects were undertaken. The above-mentioned case studies include Brownstone Park, Quarry Falls, Bellwood Quarry, Butchart Gardens, Groundscaper Hotel. (McCandless, 2013)

The research paper, 'The Landscape Attractiveness of Abandoned Quarries' written by Elżbieta Baczyńska, Marek W. Lorenc, Urszula Kaźmierczak is a trial for presenting high attractiveness of shape form in abandoned quarry areas, as well as for indicating social interest in the areas in terms of their attractiveness. Methods used for the research are as follows: the semantic differential technique (also called Osgood's method), the entropy method, and the method of point bonitation. In order to verify the procedure suggested, 10 objects (quarries) located in the area of the Ślęża Landscape Park with its buffer zone were studied. In order to determine some additional partial criteria and integrate them with the criteria of pre-existing methods, which are the basis for developing the procedure of abandoned quarry landscape attractiveness, the given three research methods were used in the paper, after modifications of a procedure for attractiveness evaluation. (Kaźmierczak2, 2017)

'Study on sustainable landscape design of abandoned quarries - An example: Zhushan ecological park in Xuzhou' written by Zhu Dong-donga, Song Yu-shana, Li Le have discussed about the unavoidable activity of mountain mining in the process of underground construction in cities of China. They have listed some of the problems of excessive increase in the number of quarries namely – destruction of vegetation, landscape, biodiversity and ecology. The authors have analysed and studied the landscape design of Zhushan ecological park in Xuzhou, and then explored a scientific and practicable approach to the ecological restoration and landscape reconstruction of the mining quarry. (Zhu Dong-dong, 2009)

Multi-Criteria Decision Analysis for an Abandoned - Quarry in the Evros Region (NE Greece) written by Sapfo Tsolaki-Fiaka , George D. Bathrellos and Hariklia D. Skilodimou identified the impacts of abandoned quarries and to examine scenarios for their restoration. Two quarries were selected as case studies, which are located in the Evros Region (NE Greece). The 'promethee' method is a multi-criteria decision analysis approach and was applied to rank the alterative scenarios. The results show that the "do nothing" scenario is the worst solution for both quarries. In terms of socio-economic impacts, both abandoned quarries are affected by illegal extraction of aggregates. The complete lack of security in both quarries has resulted in the illegal dumping of urban waste within the quarry area. More over the lack of quarry fencing

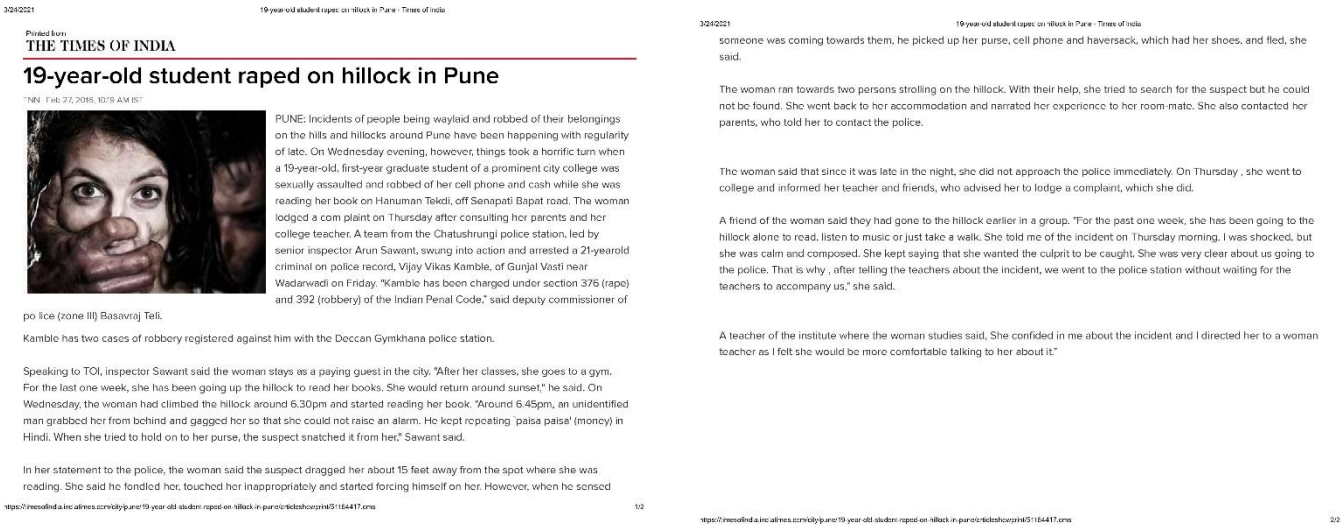
endangers the lives of inhabitants or visitors because of the possible failure of existing slopes. (Sapfo Tsolaki-Fiaka, 2018)

All the five papers prove that sustainable redevelopment is a solution for abandoned, resource-depleted quarries that benefits everyone. By encouraging the rehabilitation of land disturbed by quarrying, society can remedy the negative effects of anthropogenic industrial activity. The redevelopment of quarries can both benefit humans and lessen the environmental impact of quarrying without removing quarrying as a global and regional industry. Rehabilitation of quarries can yield so many positive social, economic, and environmental that it only makes sense that they should be reintroduced into society after their resources are depleted. Although remediation is a costly feat for most quarry sites, the benefits seen in the cases that have been presented display how the costs will be outweighed by benefits, and adaptive re-use should be undertaken as measures to make our cities more ecologically healthy and aesthetically pleasing.

The research papers written in the past state examples of case studies of the quarries that are located outside India. Very less research regarding the study regarding the redevelopment of quarries has taken place in the Indian context. So, a case of ARAI, a stone quarry located in the city of Pune in India is taken up for this study.

3.2 REVIEW OF THE RELATED NEWS ARTICLES

News articles regarding the threats in ARAI nature trail – 1



3/24/2021 19-year-old student raped on hillock in Pune - Times of India

Printed from
THE TIMES OF INDIA

19-year-old student raped on hillock in Pune

TNN | Feb 27, 2015, 10.19 AM IST

PUNE: Incidents of people being waylaid and robbed of their belongings on the hills and hillocks around Pune have been happening with regularity of late. On Wednesday evening, however, things took a horrific turn when a 19-year-old, first-year graduate student of a prominent city college was sexually assaulted and robbed of her cell phone and cash while she was reading her book on Hanuman Tekdi, off Senapati Bapat road. The woman lodged a com plaint on Thursday after consulting her parents and her college teacher. A team from the Chatushrungi police station, led by senior inspector Arun Sawant, swung into action and arrested a 21-yearold criminal on police record, Vijay Vikas Kamble, of Gunjal Vasti near Wadarwadi on Friday. "Kamble has been charged under section 376 (rape) and 392 (robbery) of the Indian Penal Code," said deputy commissioner of po lice (zone III) Basavraj Teli.

Kamble has two cases of robbery registered against him with the Deccan Gymkhana police station.

Speaking to TOI, inspector Sawant said the woman stays as a paying guest in the city. "After her classes, she goes to a gym. For the last one week, she has been going up the hillock to read her books. She would return around sunset," he said. On Wednesday, the woman had climbed the hillock around 6.30pm and started reading her book. "Around 6.45pm, an unidentified man grabbed her from behind and gagged her so that she could not raise an alarm. He kept repeating `paisa paisa' (money) in Hindi. When she tried to hold on to her purse, the suspect snatched it from her," Sawant said.

In her statement to the police, the woman said the suspect dragged her about 15 feet away from the spot where she was reading. She said he fondled her, touched her inappropriately and started forcing himself on her. However, when he sensed

https://timesofindia.indiatimes.com/city/pune/19-year-old-student-raped-on-hillock-in-pune/articleshow/print/51164417.cms 1/2

3/24/2021 19-year-old student raped on hillock in Pune - Times of India

someone was coming towards them, he picked up her purse, cell phone and haversack, which had her shoes, and fled, she said.

The woman ran towards two persons strolling on the hillock. With their help, she tried to search for the suspect but he could not be found. She went back to her accommodation and narrated her experience to her room-mate. She also contacted her parents, who told her to contact the police.

The woman said that since it was late in the night, she did not approach the police immediately. On Thursday , she went to college and informed her teacher and friends, who advised her to lodge a complaint, which she did.

A friend of the woman said they had gone to the hillock earlier in a group. "For the past one week, she has been going to the hillock alone to read, listen to music or just take a walk. She told me of the incident on Thursday morning. I was shocked, but she was calm and composed. She kept saying that she wanted the culprit to be caught. She was very clear about us going to the police. That is why , after telling the teachers about the incident, we went to the police station without waiting for the teachers to accompany us," she said.

A teacher of the institute where the woman studies said, She confided in me about the incident and I directed her to a woman teacher as I felt she would be more comfortable talking to her about it."

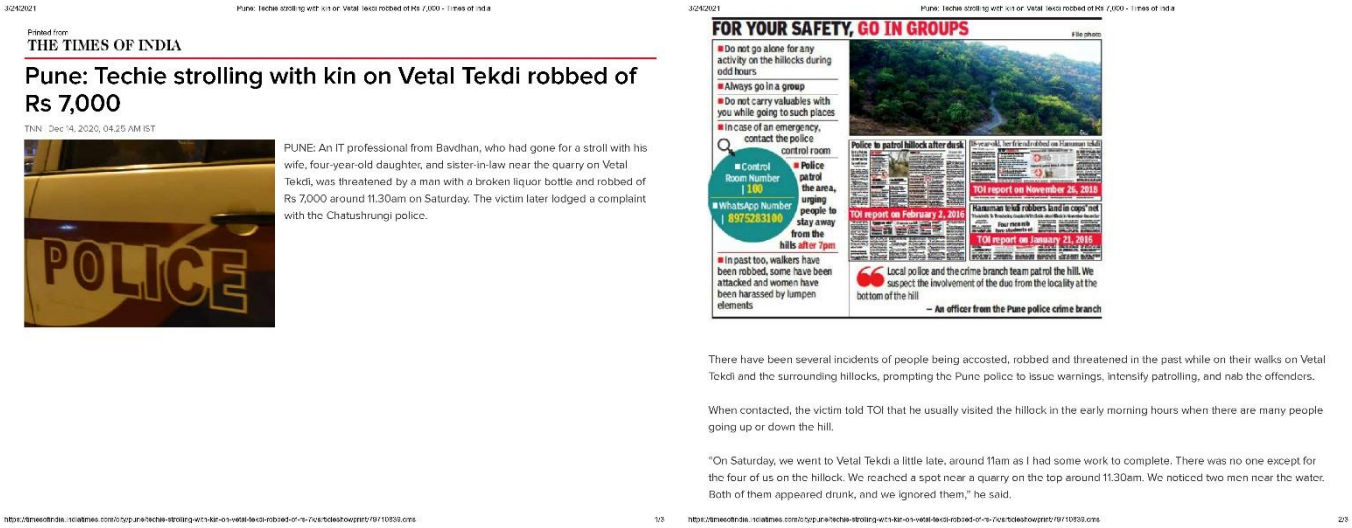
https://timesofindia.indiatimes.com/city/pune/19-year-old-student-raped-on-hillock-in-pune/articleshow/print/51164417.cms 2/2

Fig 4 – News article no. 1

Source - Times of India

A news article From the Times of India dated Feb 2015 reports a case of sexual assault and robbery that happened post sunset at around 6:45pm. The victim was 19 years old and alone when the incident happened.

News articles regarding the threats in ARAI nature trail – 2



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THE TIMES OF INDIA

Pune: Techie strolling with kin on Vetal Tekdi robbed of Rs 7,000

TNN Dec 14, 2020, 04.25 AM IST

PUNE: An IT professional from Bavdhan, who had gone for a stroll with his wife, four-year-old daughter, and sister-in-law near the quarry on Vetal Tekdi, was threatened by a man with a broken liquor bottle and robbed of Rs 7,000 around 11.30am on Saturday. The victim later lodged a complaint with the Chatushrungi police.

There have been several incidents of people being accosted, robbed and threatened in the past while on their walks on Vetal Tekdi and the surrounding hillocks, prompting the Pune police to issue warnings, intensify patrolling, and nab the offenders.

When contacted, the victim told TOI that he usually visited the hillock in the early morning hours when there are many people going up or down the hill.

"On Saturday, we went to Vetal Tekdi a little late, around 11am as I had some work to complete. There was no one except for the four of us on the hillock. We reached a spot near a quarry on the top around 11.30am. We noticed two men near the water. Both of them appeared drunk, and we ignored them," he said.

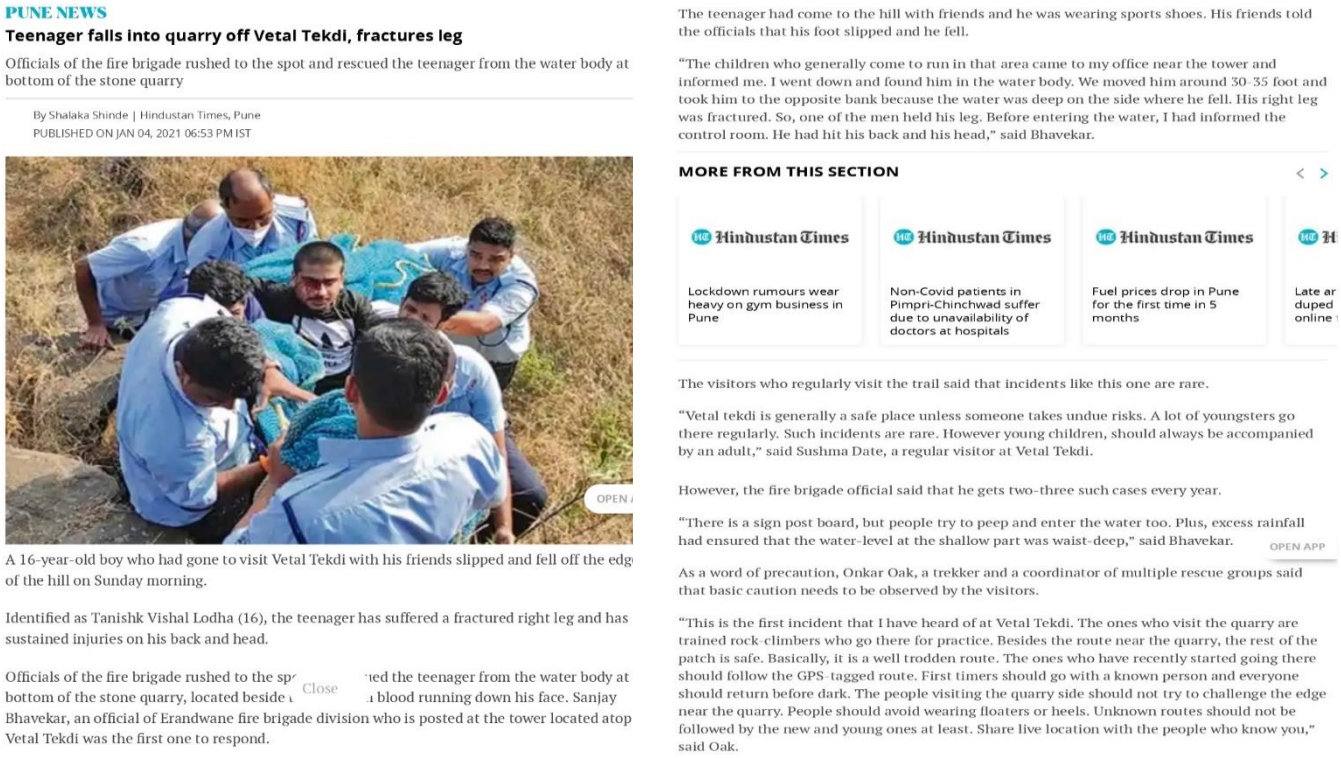
Fig 5 – News article no. 2

Source - Times of India

Another news article from the Times of India dated Dec 2020 reports a case of robbery of Rs. 7,000 that happened at around 11:30am in the morning. The victim was an IT professional and was with his wife, four-year-old daughter and his sister-in-law when the incident happened. TOI mentions other news articles of theft that have been registered with the police (two from 2016 and one from 2018).

The police have also issued guidelines asking people to go in groups and to not stay in the premises after 7:00pm. Police officers have stated that the suspects involved in such cases belong to the locality at the bottom of the hill.

News articles regarding the threats in ARAI nature trail - 3



PUNE NEWS

Teenager falls into quarry off Vetal Tekdi, fractures leg

Officials of the fire brigade rushed to the spot and rescued the teenager from the water body at bottom of the stone quarry

By Shalaka Shinde | Hindustan Times, Pune
PUBLISHED ON JAN 04, 2021 06:53 PM IST

A 16-year-old boy who had gone to visit Vetal Tekdi with his friends slipped and fell off the edg of the hill on Sunday morning.

Identified as Tanishk Vishal Lodha (16), the teenager has suffered a fractured right leg and has sustained injuries on his back and head.

Officials of the fire brigade rushed to the sp ued the teenager from the water body at bottom of the stone quarry, located beside a blood running down his face. Sanjay Bhavekar, an official of Erandwane fire brigade division who is posted at the tower located atop Vetal Tekdi was the first one to respond.

The teenager had come to the hill with friends and he was wearing sports shoes. His friends told the officials that his foot slipped and he fell.

"The children who generally come to run in that area came to my office near the tower and informed me. I went down and found him in the water body. We moved him around 30-35 foot and took him to the opposite bank because the water was deep on the side where he fell. His right leg was fractured. So, one of the men held his leg. Before entering the water, I had informed the control room. He had hit his back and his head," said Bhavekar.

MORE FROM THIS SECTION

Hindustan Times — Lockdown rumours wear heavy on gym business in Pune

Hindustan Times — Non-Covid patients in Pimpri-Chinchwad suffer due to unavailability of doctors at hospitals

Hindustan Times — Fuel prices drop in Pune for the first time in 5 months

The visitors who regularly visit the trail said that incidents like this one are rare.

"Vetal tekdi is generally a safe place unless someone takes undue risks. A lot of youngsters go there regularly. Such incidents are rare. However young children, should always be accompanied by an adult," said Sushma Date, a regular visitor at Vetal Tekdi.

However, the fire brigade official said that he gets two-three such cases every year.

"There is a sign post board, but people try to peep and enter the water too. Plus, excess rainfall had ensured that the water-level at the shallow part was waist-deep," said Bhavekar.

As a word of precaution, Onkar Oak, a trekker and a coordinator of multiple rescue groups said that basic caution needs to be observed by the visitors.

"This is the first incident that I have heard of at Vetal Tekdi. The ones who visit the quarry are trained rock-climbers who go there for practice. Besides the route near the quarry, the rest of the patch is safe. Basically, it is a well trodden route. The ones who have recently started going there should follow the GPS-tagged route. First timers should go with a known person and everyone should return before dark. The people visiting the quarry side should not try to challenge the edge near the quarry. People should avoid wearing floaters or heels. Unknown routes should not be followed by the new and young ones at least. Share live location with the people who know you," said Oak.

Fig 6 – News article no. 3

Source - Hindustan Times

Another news article from Hindustan Times dated Jan 2021 reports a case of a 16-year-old teenager who fell down into the quarry off Vetal tekdi and sustained injuries on his back and head. According to the reports, the boy was wearing sports shoes but he slipped and fell. The Fire Brigade official has stated that two – three cases such cases every year.

4.0 OBJECTIVES OF THE STUDY

There were 4 objectives.

- Objective one was to examine the frequency of visitation of users to ARAI stone quarry nature trail.
- The second objective was to document the opinions about the visitors past experiences and satisfaction levels of visiting the nature trail.
- The third objective was to identify the exact nature of barriers, threats and obstacles experienced by the users of the trail.
- The fourth objective was to identify the interventions that would enhance the experience of the user using the ARAI nature trail.

5.0 METHODOLOGY

The research conducted in the past have discussed about the quarries that are located out of India. To study a quarry in India in terms of user experience and safety, an online form survey method was adopted. The questions included in the questionnaire were both qualitative and quantitative. The questionnaire consisted of open ended and close ended questions to get a holistic understanding of the experiences, barriers encountered and the scope of improvement with respect to the ARAI stone quarry.

The respondents in this study included people of ages 8 years and above, most of which who live in Pune, mainly from urban areas, and are regular visitors at ARAI stone quarry's nature trail. The sample of respondents represents a diverse population of people who have visited ARAI at least once with respect to the personal characteristics such as age, gender, profession, frequency of visits, challenges faced at ARAI, positive and negative experiences of the same. Primary data collection was done by looking up news articles from the past which throw light on the issues and threats experienced in the ARAI stone quarry.

Post the secondary data collection of news articles, a structured google form was prepared. It was then administered online to respondents who had visited the ARAI stone quarry at least once. The google survey form was circulated on April 7, 2021. The qualitative data consisting of descriptive answers collected from open ended questions was analyzed using constant comparison method. The quantitative data was statistically analyzed by coding.

The key questions posed were –

Set A – For studying the personal information –

- *Name*
- *Age*
- *Gender*
- *Profession*
- *In which are do you stay*

Set B – For studying the frequency of visitation

- *How often do you visit ARAI?*
- *What time of the day do you visit?*
- *Do you visit in a group / alone?*

Set C – For studying the personal experiences –

- *How have been your experiences of visiting ARAI in the past?*
- *What challenges do you face at ARAI?*
- *What is ARAI (Vetal Tekdi) for you?*

Set D – For studying the issues identified by the users –

- *Rate according to your past experiences at ARAI –*

1. *Safety and security*
2. *Vandalism*
3. *Ambience*
4. *Cleanliness*
5. *Ease of way – finding.*

Set E – For studying possible interventions at ARAI.

- *What kind of spaces would you like to have along the Vetal Tekdi nature trail?*
- *What activities would you enjoy participating in ARAI?*
- *What are the interventions that would make your time spent in ARAI better? (any three)*

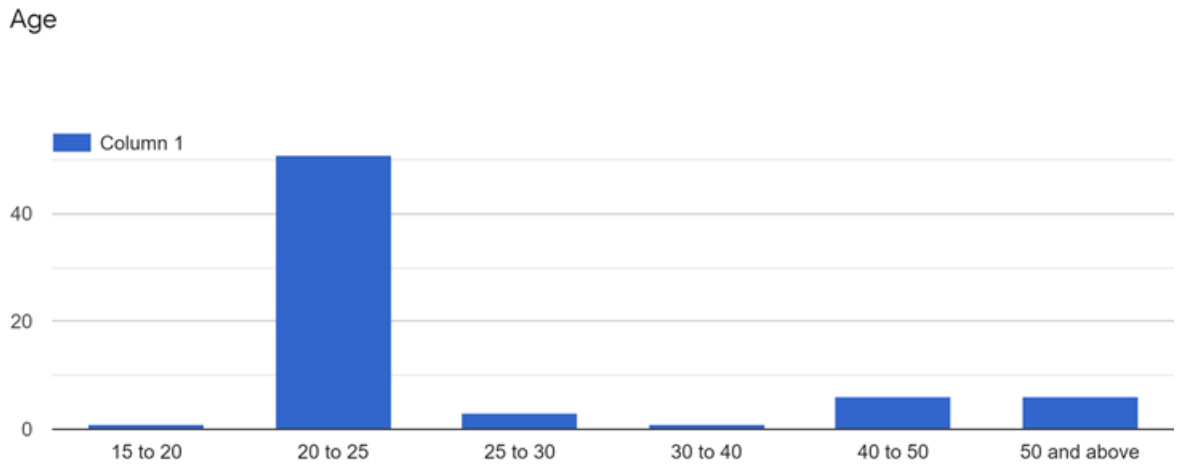
6.0 ANALYSIS

A total of 68 respondents were interviewed and included for the purpose of analysis. Out of the total respondents, maximum respondents were students having ages between 20 – 25 years.

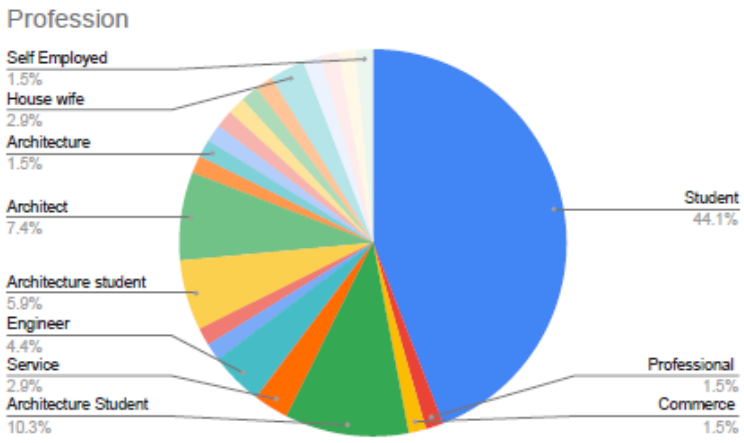
The survey was conducted for understanding the positive and negative experiences faced by the people who regularly visit ARAI. This study examined the various challenges faced by the visitors, the facilities that were lacking according to them and the possible interventions that will enhance the experiences for the visitors. A quantitative and qualitative research methodology was adopted.

In-person interviews and online google form survey method was employed to get insights from 68 respondents from Pune city. The experiences, challenges and the opinions shared by the respondents were highlight the various issues faced at ARAI. The findings of the study can be applied to develop the nature trail along ARAI stone quarry.

6.1.1 AGE OF THE RESPONDENTS

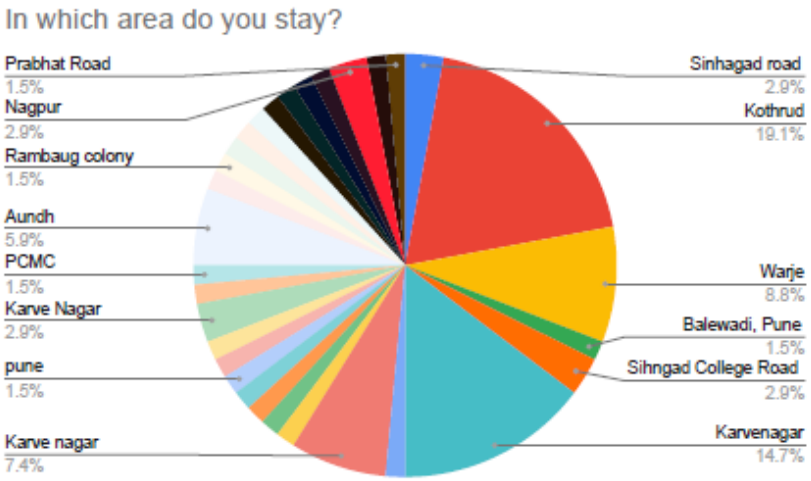


6.1.2 PROFESSIONS OF THE RESPONDENTS



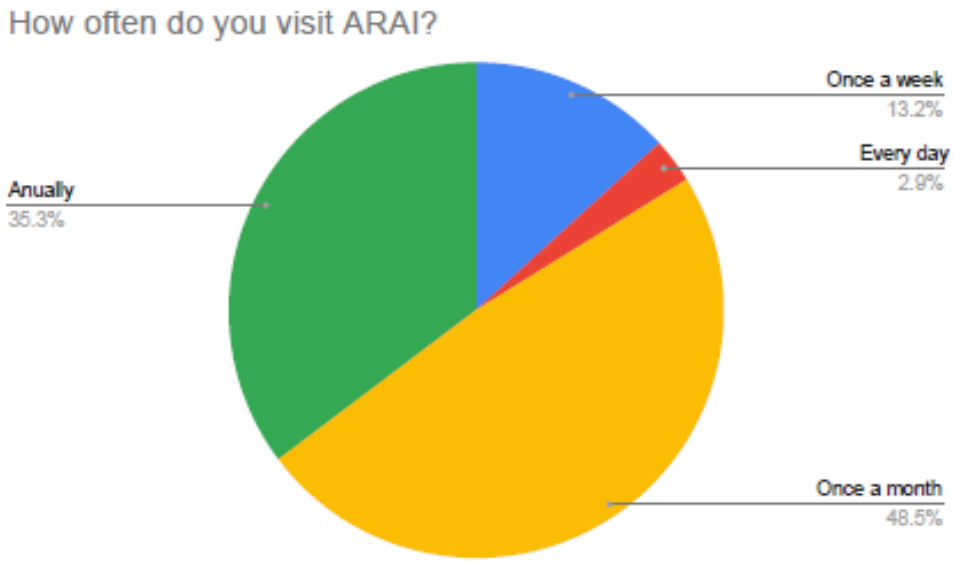
Pie chart showing the different professions of the respondents

6.1.3 AREA OF STAY OF THE RESPONDENTS



Pie chart showing the residential areas of the respondents

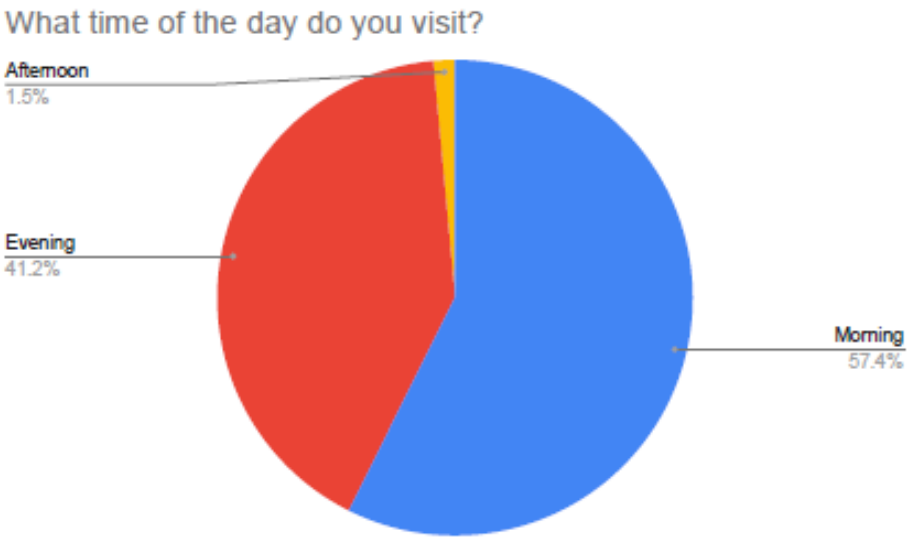
6.2 FREQUENCY OF VISITATION



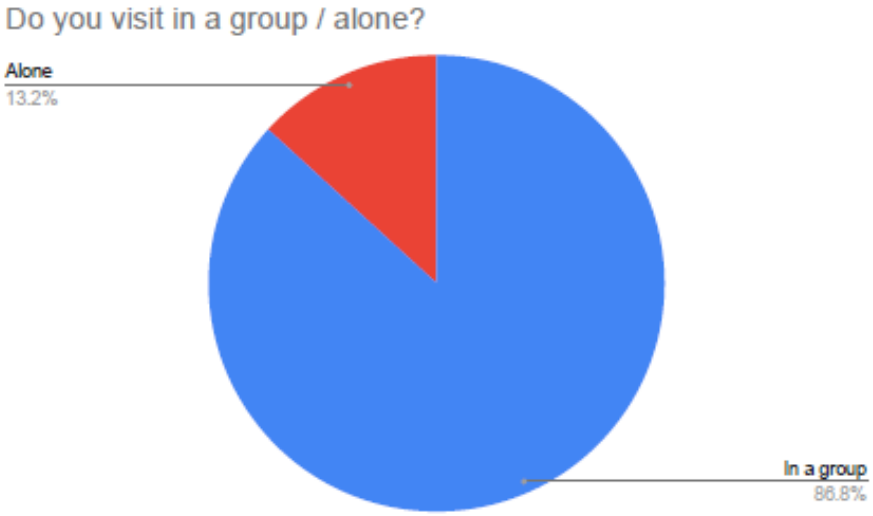
Pie chart showing the frequency of visiting ARAI of the respondents

It was found that 48.5% of the respondents visit ARAI nature trail once a month and about 35.3% visit annually, 13% of respondents visit every week and a few respondents (3%) visit every day.

Cross tabulation results across the age groups reveal that with increasing age, the frequency of visit to the nature trail is decreasing. Another cross-tabulation result across the area of the respondent's residence show that people living in Karve nagar (within a radius of 3 kms) frequented ARAI more (once a week)



Pie chart showing the visiting time of the respondents



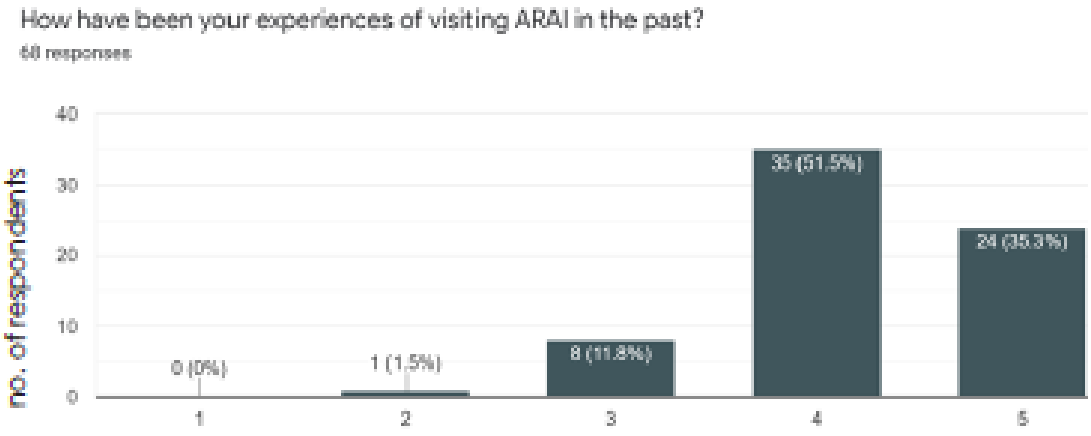
It was found that maximum respondents, i,.e. 92% visit ARAI in groups. It is also seen that males visit ARAI more often than females and females are observed to visit in groups, probably because of safety concerns.

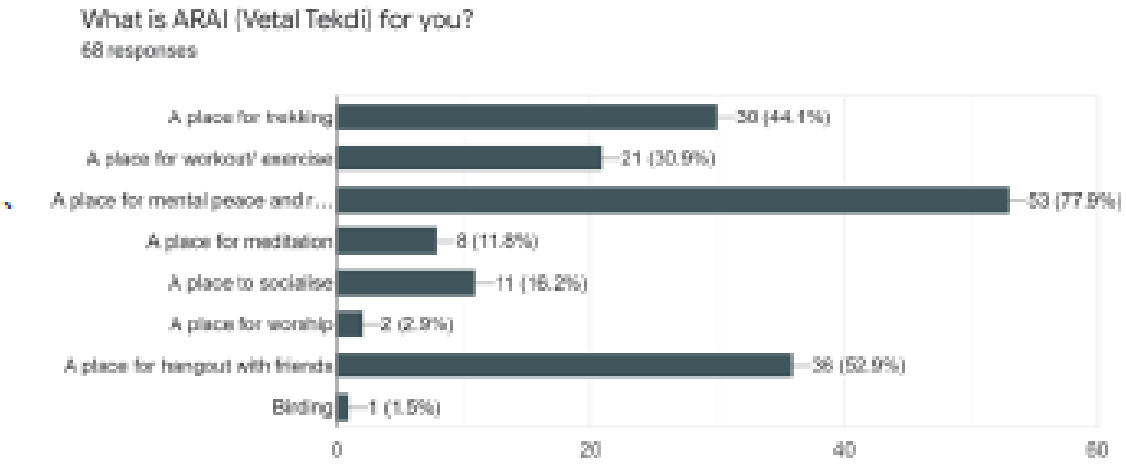
It was found that maximum respondents, i,.e. 92% visit ARAI in groups. It is also seen that males visit ARAI more often than females and females are observed to visit in groups, probably because of safety concerns.

6.3 SATISFACTION LEVELS OF RESPONDENTS WITH RESPECT TO THEIR VISITS TO ARAI, PUNE

Survey on the perceived satisfaction level of the past experiences of visiting ARAI nature trail revealed that 52% of the respondents had positive experiences and 35% respondents had highly positive experiences. No respondents rated the visiting experience of ARAI nature trail as extremely negative.

Reason given by the respondents for rating their experiences on a comparatively lower scale is the safety concerns that they had with respect to the trail.





For most of the respondents(78%), ARAI is a place for mental peace and relaxation, it is also a place to socialise for 50% respondents. For 45%, its a place for trekking and for 30% its a place for workout and exercising.

6.3.1 POSITIVE EXPERIENCES OF THE RESPONDENTS AT ARAI, PUNE

Qualitative analysis of the descriptive reasons shared by the respondents, revealed the following as primary factors for high satisfaction levels –

- Existing ecology – well maintained diverse flora and fauna.
- Peaceful amidst the chaos of the city.
- Refreshing and rejenuvating.
- Excellent scenic views.
- Respondents have emotional sentiments attached to this trail.

The above factors for high satisfaction levels have been abstracted from the numerous and detailed feedbacks given by the respondents. Some of the most insightful ones are mentioned below –

"Feels fresh away from the traffic and pollution, Get to see cute dogs and breath taking sites."

- *"flora and fauna are amazingly maintained."*
- *"Serene, calm, positive vibes."*
- *"Natural scenic landscape in the middle of the city, evergreen, refreshing."*

- *"We can connect with nature in the centre of the city, mental peace."*
- *"It is very pleasant and chill place to hang out."*
- *"Surrounding nature, quite experience while sitting near quarry."*
- *"Scenic views of nature in different seasons and the beautiful encounter of muster of gorgeous peacocks /peafowl."*
- *"Watching sunset/sunrise at the quarry area is an amazing experience."*
- "*the existing natural features make the place ideal to visit after a long and tiring day."*
- *"Natural trails, minimal human intervention."*
- *"The lush green settings the place has to offer are truly rejuvenating"*
- *"One of the best places to find peace amidst the hustle and bustle of the city. I've been visiting ARAI since I was a kid so this place is too close to my heart!"*
- *"Nature is a thing that makes everyone fresh and everyone loves that feeling. Positive things include enough parking space, good roads, the overall presence of large trees & good spots available for exercise."*

6.3.2 NEGATIVE EXPERIENCES OF THE RESPONDENTS AT ARAI, PUNE

Qualitative analysis of the descriptive reasons shared by the respondents, revealed the following as primary factors for the negative experiences –

- Lack of infrastructural development of public facilities.
- Poor maintenance and site management leading to discomfort
- Issues in way – finding.
- Pollution.

The above factors for low satisfaction levels have been abstracted from the numerous and detailed feedbacks given by the respondents. Some of the most insightful ones are mentioned below –

- *"Lack of public facilities, sanitation, safety issues."*
- *"Garbage while going, lack of cleanliness."*
- *"Once me and my friend we left late from ARAI and we were not able to get any auto and security guard told us not to come here without your own vehicle that was frightening."*
- *"Not Safe after evening"*
- *"Dirt, litter, sometimes excessive crowd."*
- *"Too many people. But I guess that's due to increased health awareness among people due to corona."*
- *"No attention to the development as natural attraction"*

- *"Dusty environment, sometimes noise from quarry area. "*
- *"No lights therefore can't visit it after a time, no signage therefore got lost when first visited."*
- *"In the evening around 7 they started asking people to get out from there because its not safe for girls because there had been cases of rape."*
- *"Such a place of beauty and biodiversity is littered a lot. Mostly I have observed that liquor bottles are thrown away here in large numbers."*
- *"People are disturbing the birds and there habitat!"*
- *"The road towards ARAI is through a slum area which seems scary due to criminal minded people living there."*
- *"Never had a negative experience. But just a suggestion: the road leading to ARAI (kelewadi) could use some hygiene and cleanliness."*
- *"Unsafe for alone girls at night, money is always being stolen from two-wheelers & cars, many of friends experienced it as well, lack of way findings, being such a large area to roam and wander around , people get thirsty and water isn't available for drinking (no water fountains) , also it is a nature trail having boards of animals that exist over there, but no facilities for them as well."*

6.3.3 CHALLENGES FACED BY THE RESPONDENTS AT ARAI

Qualitative analysis of the descriptive reasons shared by the respondents, revealed the following as primary factors for the challenges faced –

• Basic infrastructure like lights along the trails missing.

• Finding routes is difficult.

• Cases of theft.

• Lack of signages.

• Access road from Kelewadi is an eye sore.

• Lack of washrooms and basic amenities.

The above factors for the challenges faced have been abstracted from the numerous and detailed feedbacks given by the respondents. Some of the most insightful ones are mentioned below –

- *"Wayfinding is difficult for me as a new visitor"*
- *"Nuisance from dogs brought by visitors"*
- *"Seclusion after a certain hour, careless waste disposal, etc."*
- *"No activity other than trail walk"*
- *"In the rainy season, one can't go to Vetal tekadi"*
- *"The place is sometimes littered with garbage"*
- *"There are no clean toilets and signage"*
- *"Not exactly a challenge, but I think way finding experience should get better. This will be beneficial for new visitors."*
- *"1)Transportation, it is difficult to reach the place when you don't have any vehicles.2) One can easily get lost in the confusing trails as there are no navigations "*
- *"Less security, no resting spaces, washrooms, clean drinking water"*
- *"Difficulty in wayfinding after the sunset when it gets dark. There is no drinking water facility or proper washroom in case of emergency."*
- *"It's scary to walk alone. Also maintenance is an issue."*
- *"Presence of Cattles which block the path"*
- *"People playing loud music on speakers."*

6.3.4 FACILITIES LACKING AT ARAI, PUNE AS SUGGESTED BY THE RESPONDENTS

Qualitative analysis of the descriptive reasons shared by the respondents, revealed the following as suggestions for the facilities that are lacking at ARAI–

- Lack of sanitation facilities.
- Lack of proper lighting along the trail.
- Lack of signages for way – finding.
- Lack of security for parking and also along the trail.
- Lack of dustbins, drinking water fountains.
- Lack of seating.
- Lack of transport facilities till ARAI.

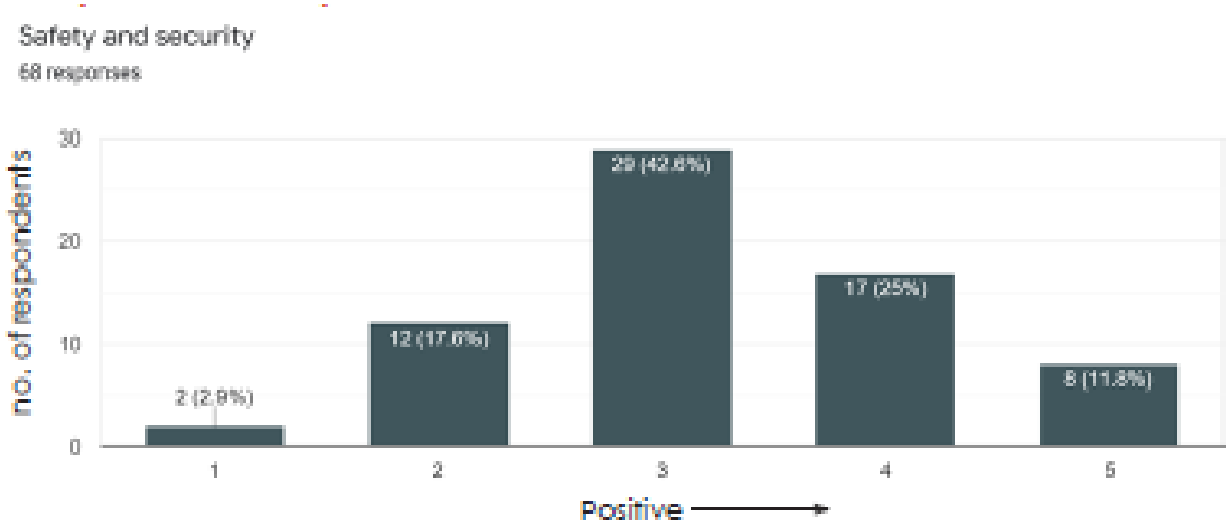
The above factors for the lack of facilities have been abstracted from the numerous and detailed feedbacks given by the respondents. Some of the most insightful ones are mentioned below –

- *"sanitation facilities, proper lighting and signages for wayfinding, security for parking."*
- *"Water drinking facility."*
- *"As per my opinion pathways should be provided for the people who visit daily." "Dustbins, maps, sittings."*
- *"Restroom, no drinking water"*
- *"Seating for people, may be a sunset sunrise point or deck, area for dogs and animal walks"*
- *"May be putting a few benches if anyone needs to rest and also some patrolling or some guards to help if there is an emergency."*
- *"I think there is no infrastructural facility required except toilet "*
- *"Proper parking areas and circulation networks"*
- *"More green space, walking tracks"*
- *"Street lights, signage."*
- *"Transport services, sittings"*
- *"More trees should be planted."*
- *"Security"*
- *"Proper access roads "*
- *"Water for strays or birds during the summers, dustbins and at least 1 washroom near the base perhaps in case of an emergency."*

- *"There should be a first aid kit somewhere on the hillock in case of any mishap. "*
- *"Availability of Drinking water, security in terms of our belongings and girls as well, way finding because I lost my way when I first went over there, and there's no range available there so it's risky."*

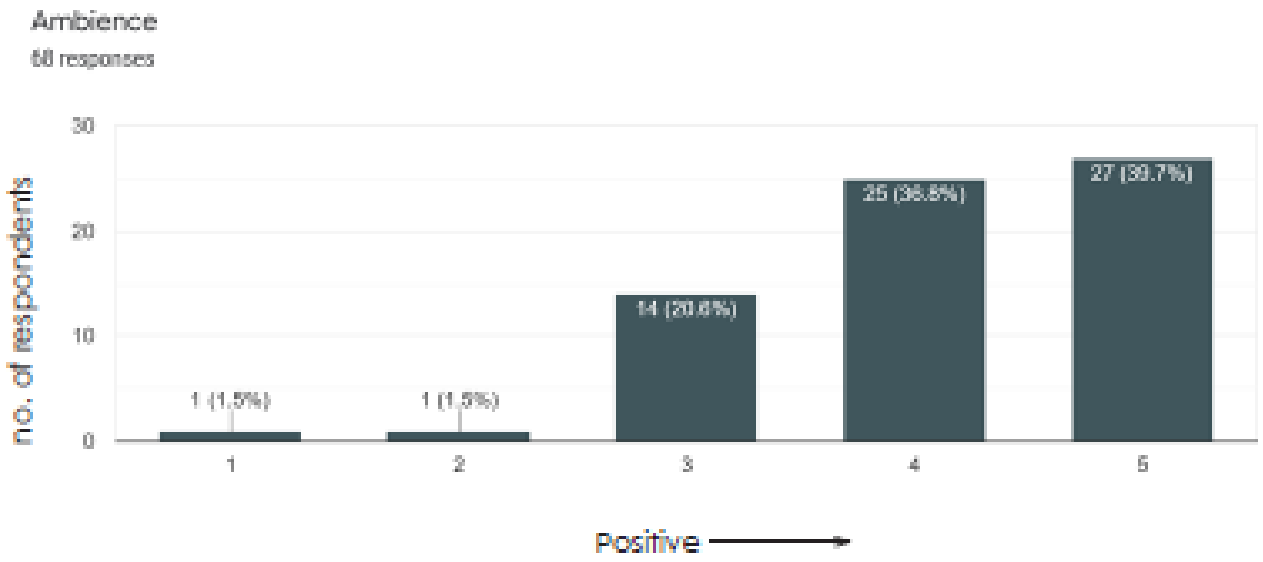
6.4 ISSUE IDENTIFICATION BASED ON EXPERIENCES OF RESPONDENTS AT ARAI

6.4.1 SAFETY AND SECURITY



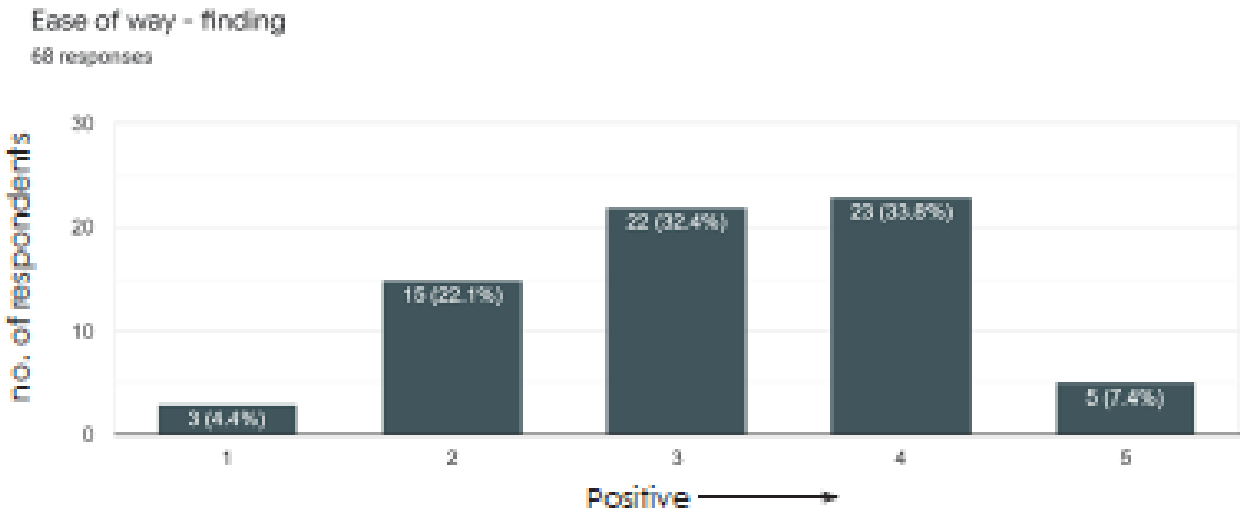
By conducting a cross tabulation analysis, it was observed that females rated the safety and security factor at ARAI very less. It is probably because of the cases of rape and theft that have happened in ARAI. It might probably also because of the lack of lighting along the nature trail.

6.4.2 AMBIENCE



By conducting a cross tabulation analysis, it was observed that females rated the safety and security factor at ARAI very less. It is probably because of the cases of rape and theft that have happened in ARAI. It might probably also because of the lack of lighting along the nature trail.

6.4.3 EASE OF WAY-FINDING



Due to lack of signages, a considerable lot of respondents (50%) respondents have stated a chaotic situation regarding the way finding along the nature trail. Some have suggested that it is a nightmare for people visiting ARAI for the first time. Some of the respondents have gotten lost while they were on the trail.

6.4.4 CLEANLINESS

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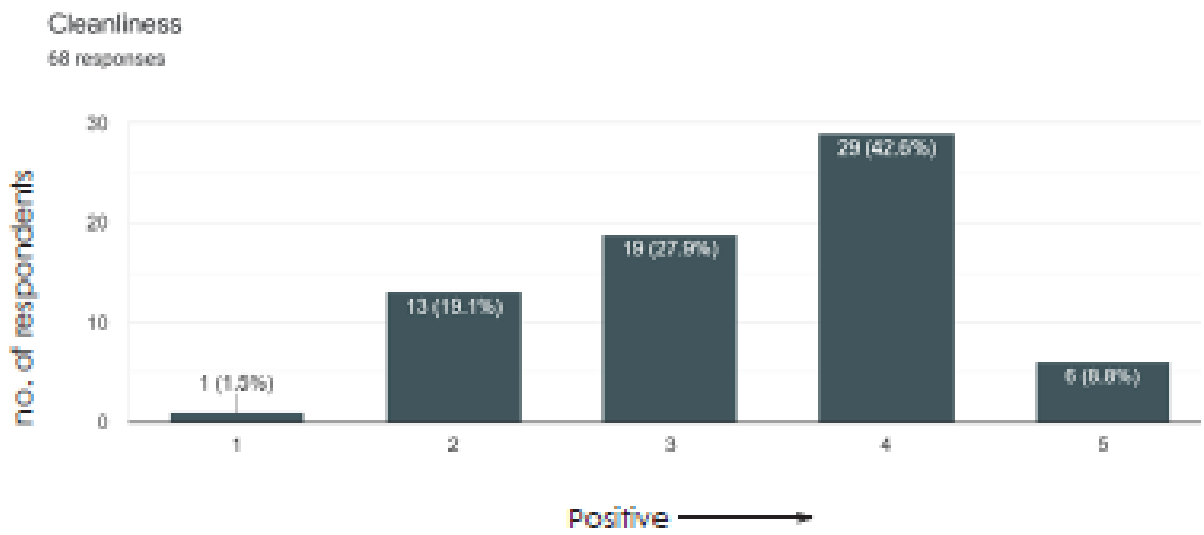


The respondents have mentioned presence of garbage along the access road to ARAI. Also, presence of liquor bottles on the nature trail has been identified as an issue

6.5.1 INTERVENTIONS AS SUGGESTED BY THE RESPONDENTS THAT WILL MAKE THEIR TIME SPENT AT ARAI MORE MEMORABLE.

Qualitative analysis of the interventions shared by the respondents, revealed the following as suggestions for the facilities that can be developed at ARAI–

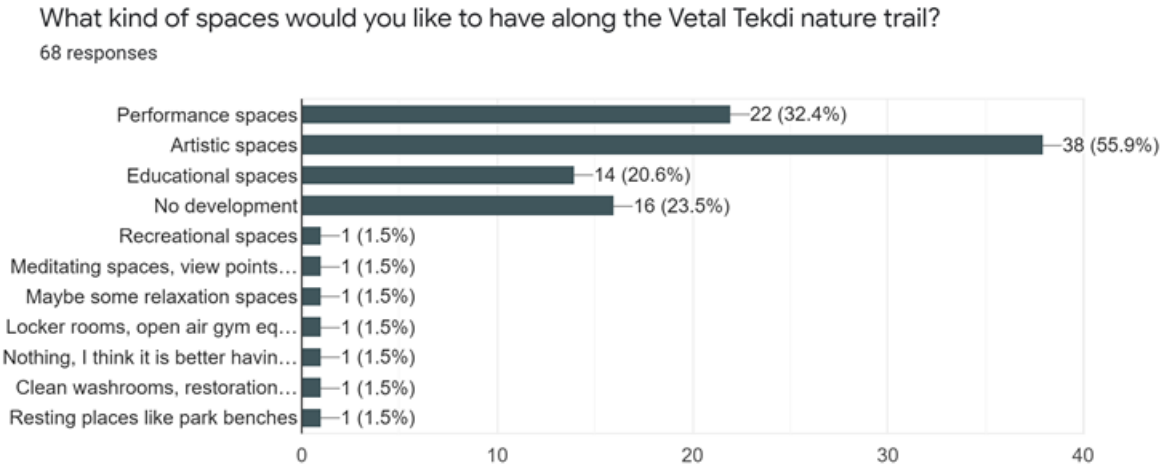
- Sanitation facilities.
- Lighting along the trail.
- Interactive signages for way – finding.
- Security for parking and also along the trail.
- Dustbins, drinking water fountains.
- Seating.
- Public transport facilities till ARAI.
- Plantation of native trees.

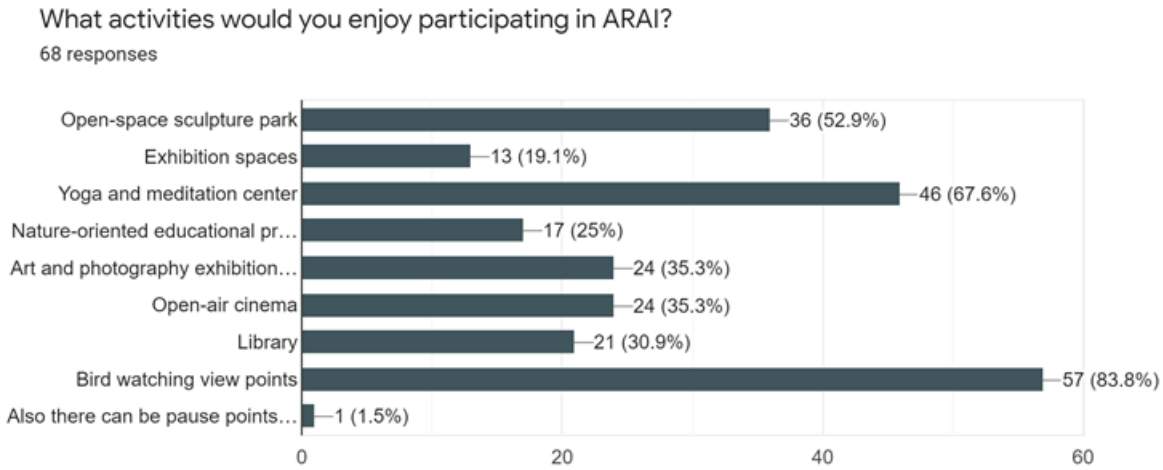
The above factors for the lack of facilities have been abstracted from the numerous and detailed feedbacks given by the respondents. Some of the most insightful ones are mentioned below –

- *"1. Public toilet and drinking water facility 2. Seating along the trail 3. Interactive signages*
- *"Public washrooms, signages, seatings"*
- *"The entry till gate should be restricted only for senior citizens and more water tanks should be installed"*
- *"pathways, providing benches, security and signages*
- *"Providing maps, seatings, clean environment"*
- *"A club house, safety/security cell"*
- *"Lighting, many barren lands can be converted into something meaningful, a source of clean water, restricting cattle into specific areas"*
- *"Seating, view point deck, space for animals"*
- *"Planting of native trees, patrolling, building a few rest points."*
- *"Retaining the existing green corridors, mine, natural features, building some interventions outside the in the "parking like public toilets, healthy food stalls etc"*
- *"Cleanliness"*
- *"Proper organization of open exercising spaces"*
- *"Washrooms, pause point to sit and relax, eateries"*
- *"Signage, food stall and street lights . "*
- *"Good view point ..develop some activities over there"*
- *"Toilets or some places of interventions for seating "*
- *"Proper area for seating , crowd management"*
- *"1. Trees 2. Water facility 3. Hygiene"*
- *"1. Plant more trees, 2. Artifical nest "*
- *"Railing near quarry, proper pathway"*
- *"Trees lake and the birds"*
- *"Lighting during the evening"*
- *"Dustbins at regular intervals, water containers, a washroom"*
- *"Way finding, drinking water facility, lights at night "*

6.5.1 SPACES THAT THE RESPONDENTS WANT ALAONG THE TRAIL IN ARAI (VETAL TEKDI), PUNE

Survey on the kind of spaces that the respondents would like to have in ARAI and the majority (56%) of people opted for artistic spaces and 33% opted for performance spaces. However 23% respondents felt that no development is needed in ARAI. By cross-tabulation, it can be observed that people who ocassionally visit the trail and the ones who stay out of Pune would like to have educational spaces. Few others suggested interventions like locker rooms, clean washrooms, bird watching points, etc.





Respondents were very eager to have bird watching viewpoints, yoga and meditation space, sculpture park, art and photography pavilions, library and nature oriented educational programs.

7.0 DISCUSSION

This investigation related to the experience of people who have visited the ARAI stone quarry nature trail in Pune offers a comprehensive understanding of how abandoned stone quarries can be reused and be converted into tourist spots of attractions. This survey is based on the positive / negative experiences, challenges faced by them and the probable interventions that will enhance the experience of the nature trail. This as a whole, yielded a significant amount of data to draw general conclusions, both from the point of view of the redevelopment of ARAI as an abandoned quarry and its nature trail as well as the user experience.

On the question about the frequency of visitation of respondents to ARAI Pune, it was observed that the respondents staying in the vicinity of 3 kms visited the quarry more often. Maximum people go in groups and prefer to come back before it gets dark.

Insights shared by participants about their past experiences revealed that ARAI nature trail is a very peaceful place amidst the chaos of the city life of Pune. However, the respondents also had experiences of theft and such malpractices making this place a notorious one.

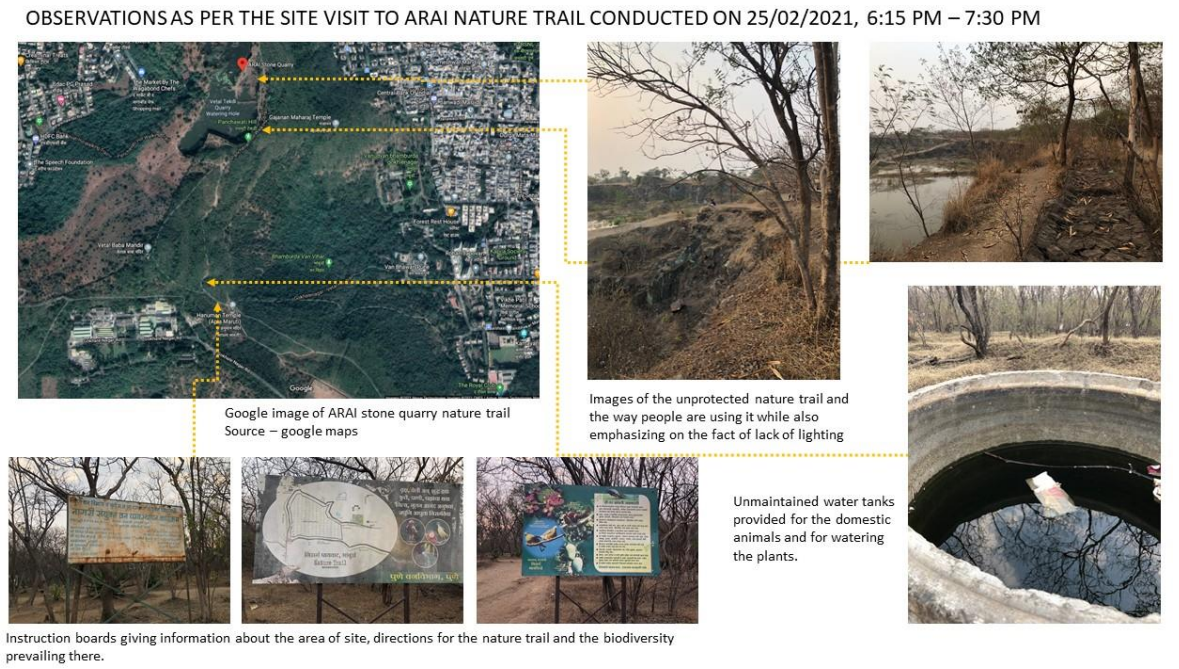
The respondents had negative experiences because of lack of infrastructural development of public facilities, poor maintenance and site management leading to discomfort, issues in way – finding and pollution. The challenges faced by them were lack of basic infrastructure like lights along the trails missing, finding routes is difficult, cases of theft, lack of signages and access road from Kelewadi is an eye sore.

Also, the nature trail around the periphery of the quarry pit can be accessed by the visitors and there is no fencing or obstruction with which safe distance between the edge of the pit and the visitor can be maintained. According to the news reports, an officer has stated that there are 2-3 cases of people falling into the pit every year.

These issues of lack of proper security, lightings along the trail to name a few have led to some unfortunate events on this trail and have in turn led to insecurity in the minds of the visitors.

The findings from this survey have brought out the dire need to intervene in ARAI to improve the experiences of the users. According to the suggestions by the respondents - Yoga and meditation spaces, visitor interpretation center, nature oriented educational programs (ecology of Vetal tekdi), first aid facility on tekdi, Eco-recreational spaces, sanitation facilities, lighting along the trail, interactive signages for way – finding, security for parking and also along the trail, dustbins, drinking water fountains, seating, public transport facilities till ARAI and plantation of native trees.

These interventions if implemented will make the experiences of people visiting the ARAI stone quarry nature trail safer and more enhanced.



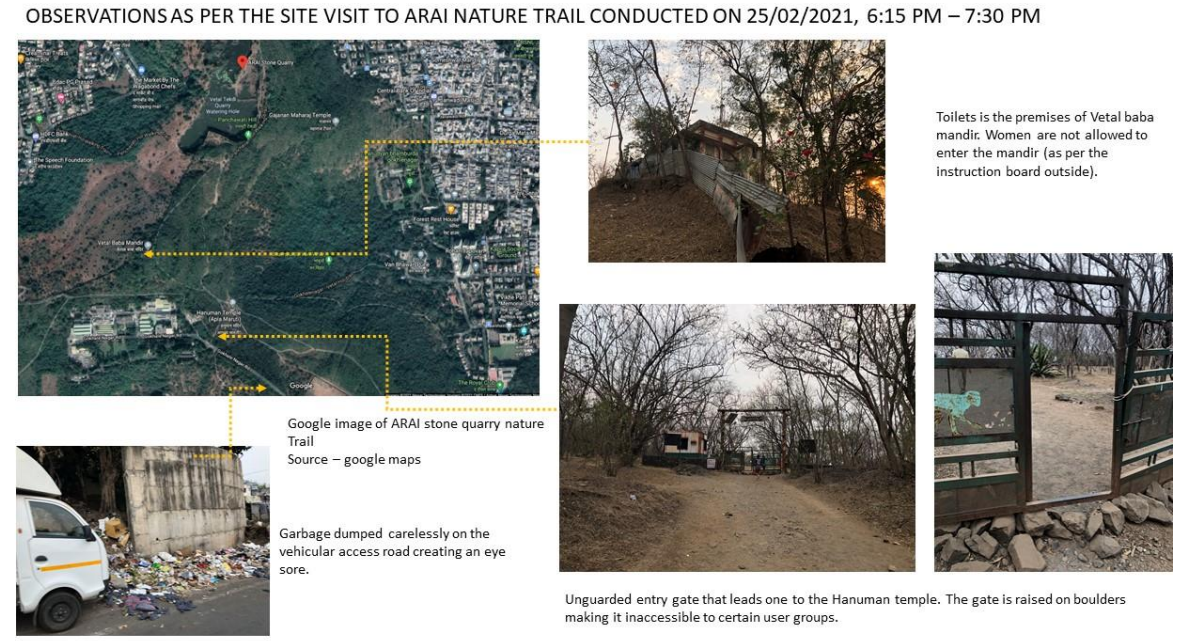


Fig 7 - Observational pictures showing the current state of ARAI, Pune.

8.0 ARAI STONE QUARRY NATURE TRAIL – USER GROUP

The undulating hill tracks of Vetal Tekdi are dotted with walkers, joggers, cyclists and trekkers. Under giant trees, young boys play improvised ball games.

On a platform near a Hanuman temple, people of all ages catch up with friends or rest their limbs after a climb.

Groups from colleges, batches of senior citizens, couples and families on a picnic navigate the long grass and rocks.

At certain times of the year, Dhangars and other nomadic or semi-nomadic pastoral communities stop at Vetal Tekdi as they have for centuries during their annual migration between the western parts of Maharashtra and Konkan. Though the hill now boasts plantations of social forestry, the original flora featured grassland and only pockets of woodland, which was good for grazing animals. Their horses and sheep feed on the lush grass and other vegetation.

On the other hand, students from the slums around the hills come for peace and to study.

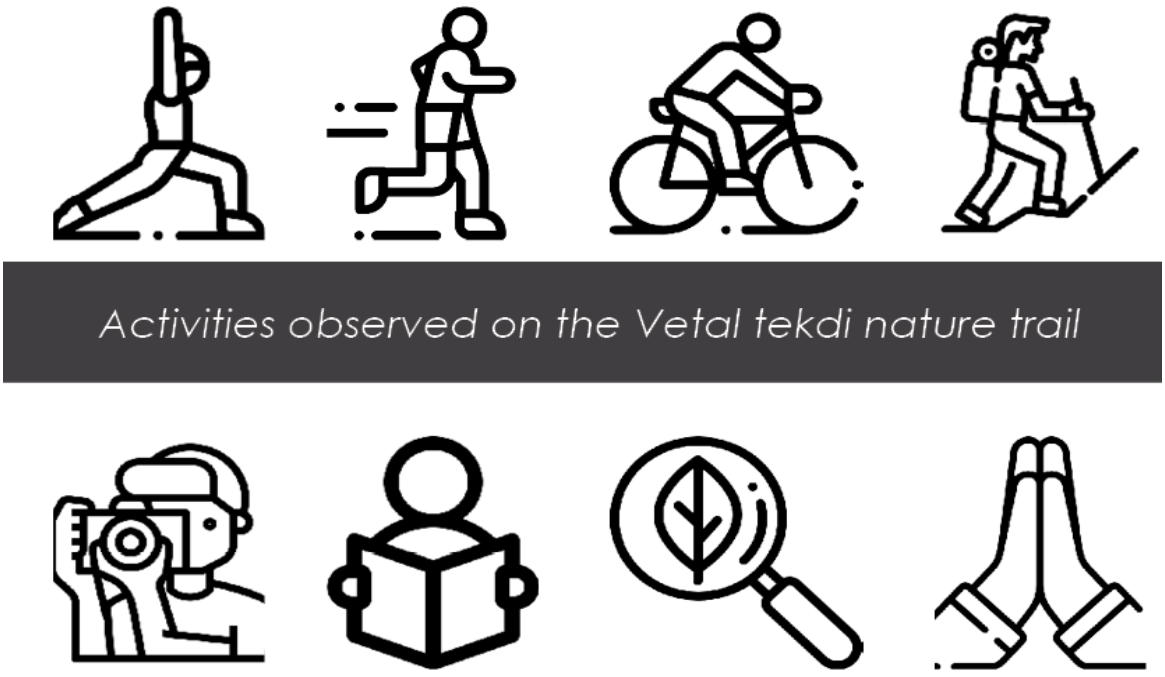


Fig 8 – Activities observed on Vetal Tekdi

9.0 INTERVIEW WITH FOREST DEPARTMENT – Mr. SURESH BURLEY AND Mr. GADVE CONDUCTED ON 27.01.2022 – 28.01.2022 AT 2:00 PM

History

The stone quarry was in a working condition till 1995. It was a basalt quarry that was crucial in the development of Pune's infrastructure owned by Mr. Pusalkar.

Expanse

60-65 hectors

Public bodies/ municipal departments who own the quarry and surrounding area

Forest department leased out 10-20 hectors land to ARAI, Indian Law Society is responsible for the maintenance of a few areas, Private owners.

Footfall mapping?

Morning: 300-400

Evening: 1000

Future plans

Compound around the quarry – stopped due to the resistance from citizen groups and NGO's

Maintenance (Y/N):

Not as such

Budget:

As and when they receive funds

Abandoned structure

BSNL old office structure,

Land owned by PMC.

Challenges daily basis

People complaining about dog bites.

News – what was done about it:

A man has been appointed who works around the trail from 6 am – 10 am and 4 pm – 7 pm.

Staff on ground:

One man.

Main office?

Security cabin but abandoned

Where?

Around the entrance of the trail and around the quarry but it is abandoned.

Down the tekdi, is there something?

Area owned by military.

What's allowed, what's not allowed – policies and norms

No construction using cement.

Construction using stone, Bamboo or any other

material is okay.

Legal bylaws?

In a regulation that was published in 1980 by the government, construction using cement is prohibited.

Regulations on what can be built

Anything that is of benefit to the forest department and the nature trail.

CCTV cameras, electricity, lighting.

None as such

Different nuisances across seasons

Gets slippery and unsafe in the rainy season.

Vanava (forest fire) in summers.

How much water gets collected in the rains?

Not measured

Maintenance of the water that gets stored in the quarry

Nil

10.0 INTERVIEW WITH KETAKI GHATE, ECOLOGIST at Oikos : for Ecological Services, Pune

Based on a call with Ketaki Ghate ma'am (16.02.22, 10:15am) and a lecture suggested by her.

Wetland – permanently or seasonally flooded, sunlight reaches the bottom level

Hydrology:

Flow: precipitation – surface – subsurface/Ground water

Salinity:

Freshwater <0.05% salts

Brackish 0.05 to 3% salts

Salt water 3.5% salts

Tidal influence:

Tidal

Non tidal

Flooding level

Hydrogeology, Geology

Catchment

Land use

Flooding levels depend on the land use of the wetland and its edges

Types of Sediments

Basalt

Hydric soil

Soil remains saturated due to the presence of water, due to this, the top layer of soil becomes anaerobic. As a result, usual terrestrial trees (amba, jamun) cannot grow there.

Hydrochemistry

- To determine the chemistry of water, use the organisms and vegetation as indicators.
- Ideal water for a wetland: no sewage influx or pollution, it should be clean, pH level, suspended solids, BOD, COD levels should be maintained.
- If this is taken care of the biodiversity flourishes.
- If the source of water – only rains, stream, spring; wetland is called oligotrophic (algal formation) – food available in a restricted amount.
- If you add nutrients – pesticides, detergents – argal blooms increase – Eutrophic

Hydrophytes

Single celled phytoplankton: algae – diatoms, dinoflagellates.

Periphytons: surface attached – rocks, wetland bottom

Macrophytes:

Free floating: duckweed, lenda (after harvesting can be used as a fertilizer)

Rooted floating: water lily, Lotus

Submerged: Hydrilla

Marginal: Typha (non-native), halad kunku, polygonum, lavale, karanj, jambhul.

Aquatic fauna

Invertebrates:

Insects

Mollusks: Snails, Limpets, Clams, Mussels

Crustaceans: Crabs, shrimps, crayfish, **branchiopods, copepods** (basic food for many fishes)

Vertebrates:

Birds

Fishes

Amphibians

Mammals

Reptiles

Trophic relationship

-Feeding guilds

-Suspension feeders – shredders – gatherers and collectors – Grazers

Organic matter (OM) – Detritus (decomposing) – coarser particle organic matter (CPOM) – Fine particle organic matter (FPOM) – Bacteria to inorganic substances.

Every faunal group is important for this food chain to function

Types of wetlands

Marine wetlands

Estuarine wetlands

Riverine wetlands

Lacustrine wetlands – Lakes – model colony lake (spring)

Palustrine wetlands – isolated – only rainy season – inflow, no outflow.

Man-made wetlands

Reservoirs

Quarries

Ponds and lakes

Salt pans

Paddy

Shrimp farms: aquaculture

Primary Productivity

Production of leaving tissue per unit time, chlorophyll

Wetlands – highest – 2500gms/ sq m/ year because of phytoplankton

Ecosystem services

Purify water (soil bio-filter technology) – introduce perennial weed, adsorbs pollution

Recycle nutrients (OM – inorganic matter)

Flood control

Recharging ground water – wells, water bodies nearby levels increase

Habitat for wildlife

Food – lotus and water chestnut plantations

Recreation

Regulate micro climate = climate change mitigation - water heats up and cools down slowly hence moderate climate is observed year long around a waterbody reducing heat island effect in cities.

Threats

Human intervention

Land use change

Pollution

Reclamation

Dams

Invasive species (suggestion - use of native species in pisciculture)

Restoration and management

Assessment: know pulse, community structure, community metabolism, water chemistry.

Micro organisms' study: phytoplankton and zooplanktons

Target special species and habitats

Identify disturbances: sewage influx

Define objective

1. Ecological – restore just for the sake of wildlife and biodiversity.
2. Integrated – economical and also maintaining biodiversity

Management

RAMSAR CONVENTION

The Ramsar Convention on Wetlands is an intergovernmental treaty adopted on February 2, 1971 in the Iranian city of Ramsar, on the southern shore of the Caspian Sea.

It came into force for India on February 1, 1982. Those wetlands which are of international importance are declared as Ramsar sites.

What can be done for ARAI stone quarry ecological restoration?

Initial proposal to create water reservoir for water scarcity

Small wall (1-2mts height) to create wetland like conditions to not let the water drain away from the quarry.

Introduce silt from other places (Pashan Lake) hydrophytes – algae, micro fauna and flora flourishes in such conditions resulting in increase in the ecological value.

Plant thorny shrubs around the periphery of the quarry to avoid accidents.

Assure protection, water should stay there.

Fortunately, there's no introduction of sewage influx.

Hypothetically can introduce pisciculture. No commercial harvesting. Can introduce it in a smaller catchment area. Management needed.

11.0 DEVELOPMENT PLAN REPORT AND EXISTING LAND USE

PUNE MUNICIPAL CORPORATION (PMC)

ELU SURVEY OF SECTOR III (Corporation, 2021)

Hill Top and Hill Slope areas account to 18.26 %. This percentage may make good the deficiency. The Bhamburda Vanvihar developed by the Forest Dept. is available for recreation off the Patrakar Nagar and Gokhale Nagar in village Shivaji Nagar Bhamburda.

In 1987 DP, HTHS were preserved for the recreation use and Water bodies in this sector accounts as 8.49%. This is due to the nalas existing in this sector and are flowing from west to east to join the Mutha River.

One thing is vital that all the existing nallas in the city are required to be preserved as it is with its available width as per land record and no portion shall be reclaimed or field with debris so as to obstruct the flow during monsoon and also water from Strom water drains to join this nallas and river ultimately.

In 1987 DP nala Chanalisation and improvement schemes have been proposed.

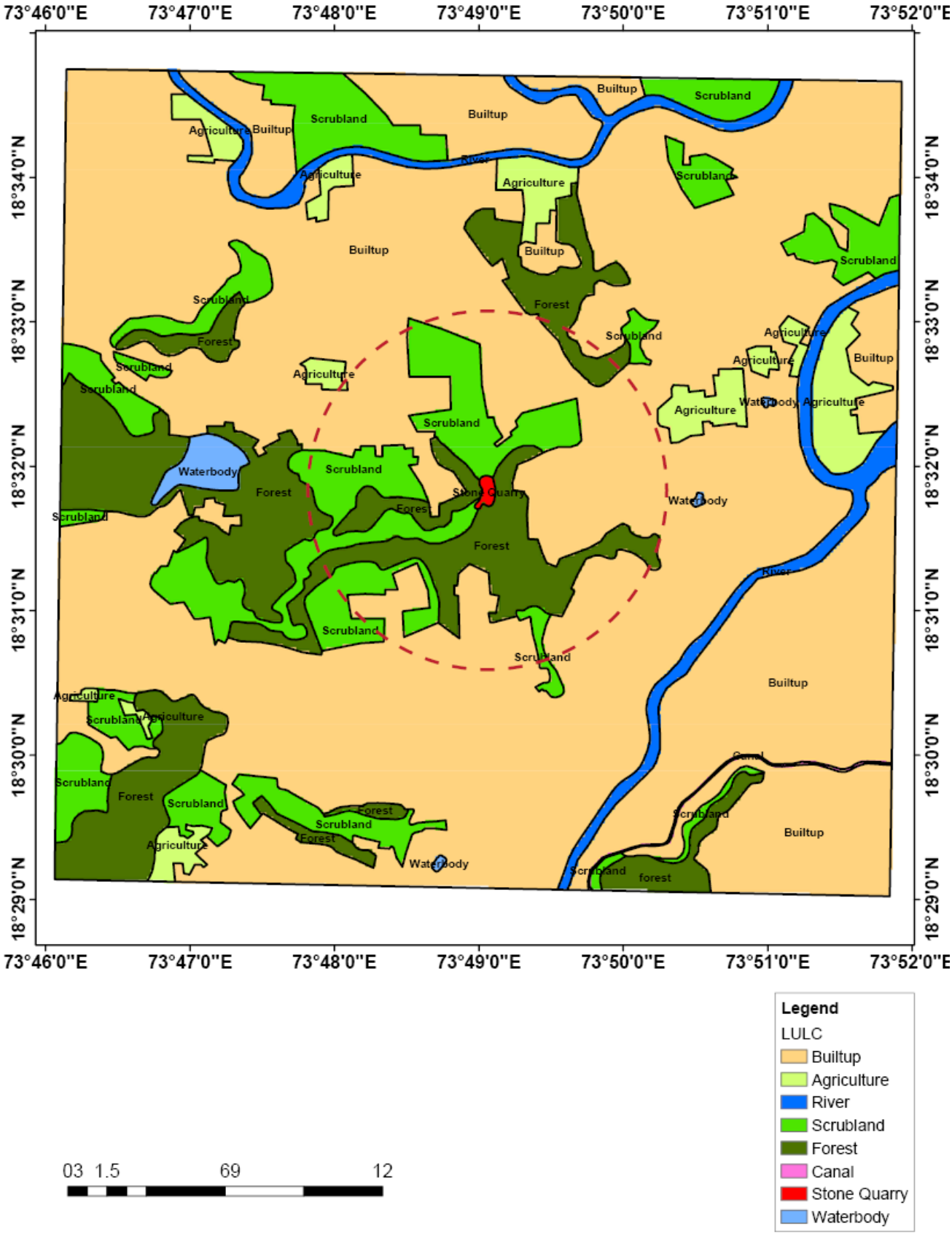


Fig 9 – LULC of ARAI nature trail

Source - ImaGIS

EXECUTIVE SUMMERY

Socio-Cultural and Community Facilities ((PMC), 2007-2027)

Socio-cultural activities such as auditorium, music, dance & drama centre/ meditation & spiritual centre etc. Exhibition –cum-Fair Ground have been reserved. The Planning Norms, Standards and Development Controls for other facilities such as old age homes, Night Shelters, Religious, etc. have also included in the development control rules.

In order to facilitate international exhibitions, Social and, Cultural recreational programs exhibitions & Public meetings, Multipurpose grounds have been reserved.

To enhances and to attract tourism, site have been reserved for science center & Planetarium near Pune University.

To provide facilities for the handicapped & spastic students, sites have been reserved for Spastic & Handicapped Rehabilitation center.

To motivate the young generation by educating them in various fields. Sites have been reserved for youth guidance Center and Youth Training Center.

This facility shall be easily available mainly to the poor and backward class. Passengers coming from different states, places, have been provided with temporary shelters, during their short waiting period before further journey Sites have been reserved for night shelters.

ENVIRONMENT STRATEGIES

Creation of a sustainable physical and social environment for improving quality of life is one of the major objectives of the plan.

Management of Natural Resources and the related environment infrastructure.

Conservation and Development of the Natural features with a view to enhancing their environmental value.

Development and preservation of open spaces, greens and landscape/ recreational areas.

So as to protect and preserve the biodiversity life/ species these stretches can be developed as boat club, with water sports activity, jogging tracks, cafeteria with large recreational spaces. Sites have been reserved for parks, amusement parks, gardens, etc. Sites have also reserved for sports activities like playgrounds, children's playgrounds, stadiums etc.

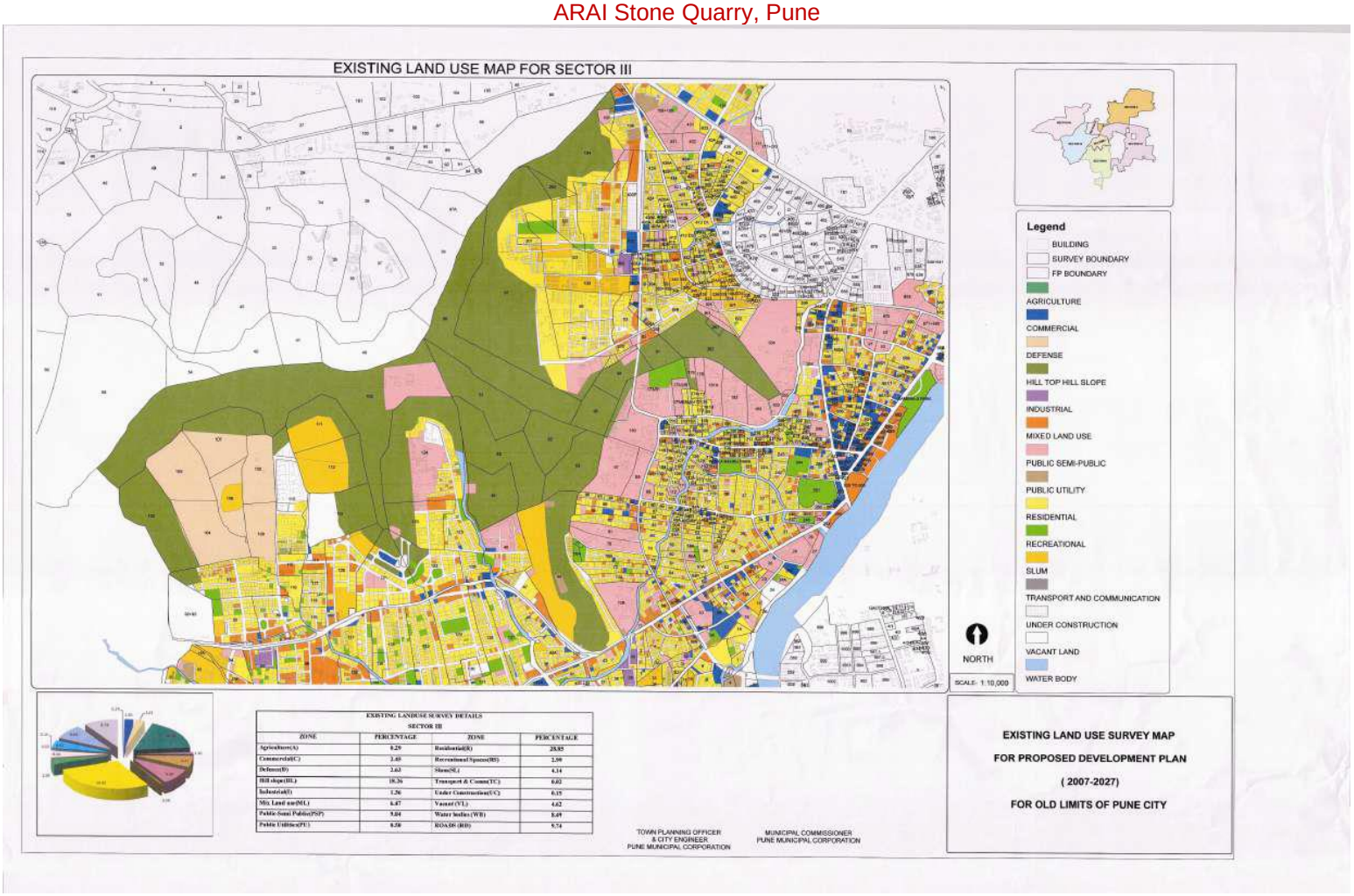


Fig 10 – Existing Land Use Survey Map for DP

Source - www.pmc.gov.in

12.0 NATIONAL MINERAL POLICY 2019

MINISTRY OF MINES,

GOVERNMENT OF MINES (MINES, 2019)

6.13 Mine Closures

Once the reserves in mine are completely exhausted there is need for scientific mine closure which will not only restore ecology and regenerate bio diversity but also take into account the socio-economic aspects of such closure. Where mining activities have been spread over a few decades, mining communities get established and closure of the mine means not only loss of jobs for them but also disruption of community life. Mine closure should be done in an orderly and systematic manner.

Government has a role in ensuring that post-production mine decommissioning and land reclamation are an integral part of the mine development process; that financial provisions for the costs incurred in mine closure are accorded a high level of priority by the industry; and that consistent approaches are adopted for efficient and effective mine reclamation and rehabilitation.

6.10 Protection of Environment

Extraction of minerals impacts other natural resources like land, water, air and forest. It is necessary to take a comprehensive view to facilitate the choice or order of land use keeping in view the needs of development as well as needs of protecting the forests, environment and ecology and to conserve biodiversity of areas to be mined.

Prevention and mitigation of adverse environmental effects due to mining in accordance with the latest scientific norms and modern afforestation practices shall form integral part of mine development strategy in every instance. All mining shall be undertaken within the parameters of a comprehensive Sustainable Development Framework which will ensure that environmental, economic and social considerations are integrated effectively in all decisions on mines and minerals issues. The guiding principle shall be that a miner shall leave the mining area in an ecological shape which is as good as it was before the commencement of mining or better with least impact on flora and fauna of the area.

With a view to reduce pollution, carbon footprint and operational costs, use of renewable sources of energy at mining sites will be encouraged through appropriate incentives. Appropriate sensitization training about environmental issues will be provided to all workers involved in mining operations.

13.0 ARAI STOE QUARRY AND NATURE TRAIL

RESEARCH AND FINDINGS (Nath, 2021)

Researcher Divyanshu Pawar, who first visited the hill in 2019, looks out at the quarry and sees the different kinds of volcanic lava activity. "The region we are living in was a volcano 65 million years ago. It is a kind of volcano that does not erupt but flows. That's why the basalt rock found here, called Deccan basalt, is black. What is special about this geology is that the compact and vesicular basalt rocks act as recharge and discharge places, allowing water to seep in and out, and accumulate in aquifers or storage houses of underground water. It is important to preserve areas like Vetal hill. With hills being cut down and no proper recharge and discharge of water happening, Pune has been suffering adverse ecological effects."

Phadke refers to Vetal Tekdi as "mini-Sahyadri", "because it is representative of many plants observed in the Sahyadri". In the flora of Vetal Tekdi, he has identified several rare species of plants and drawn attention to unique trees as well as those that are not natural to the hills but have been planted since British times.

Late historian D D Kosambi used to explore the city of Pune and its surroundings as a way to understand the past - and Vetal Tekdi was one of his regular routes. It was at Vetal Tekdi, Law College Hill and Pashan Hill, among others, that Kosambi came across small stone tools or microliths with sharp edges, blades and points that indicated the presence of prehistoric humans in the region during the Mesolithic era or the Middle Stone Age, between the Palaeolithic and Neolithic periods. "The findings confirm that man was harvesting grain, hunting, fishing and stripping animal skin to make leather in the Mesolithic period," says Palande-Datar.

Fig 11 – Vetal Baba Mandir

Source – The Indian Express

13.1 FLORA OF ARAI STONE QUARRY NATURE TRAIL

Fig 12 – Flora of Vetal Tekdi and ARAI Stone Quarry

13.2 FAUNA OF ARAI STONE QUARRY NATURE TRAIL

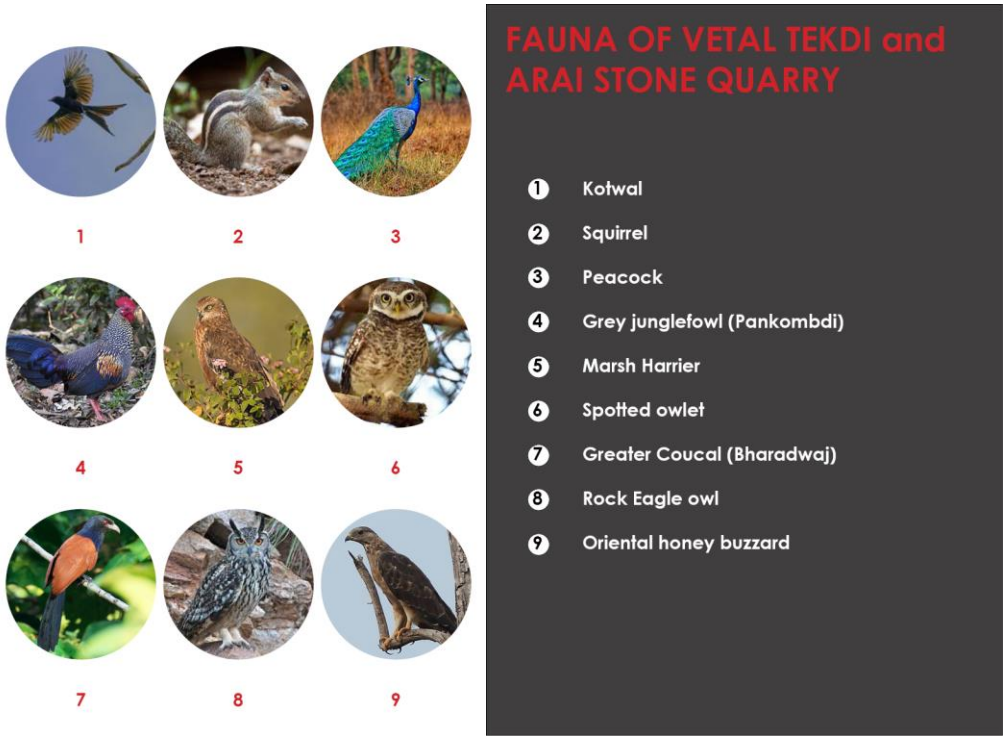


Fig 13 - Fauna of Vetal Tekdi and ARAI Stone Quarry

14.1 MACRO AND MICRO LEVEL ZONING OF EXISTING FEATURES AND ROAD NETWORKS OF ARAI STONE QUARRY NATURE TRAIL

Fig 14 – Primary, Secondary and teriary Road Network around ARAI Stone Quarry

Primary Road is the Karve Road which later converts to Paud Road. Karve road branches out into Gokhale Nagar Road which is 9 mts wide and leads up to the ARAI Office. After this secondary road, the Nature Trail starts.

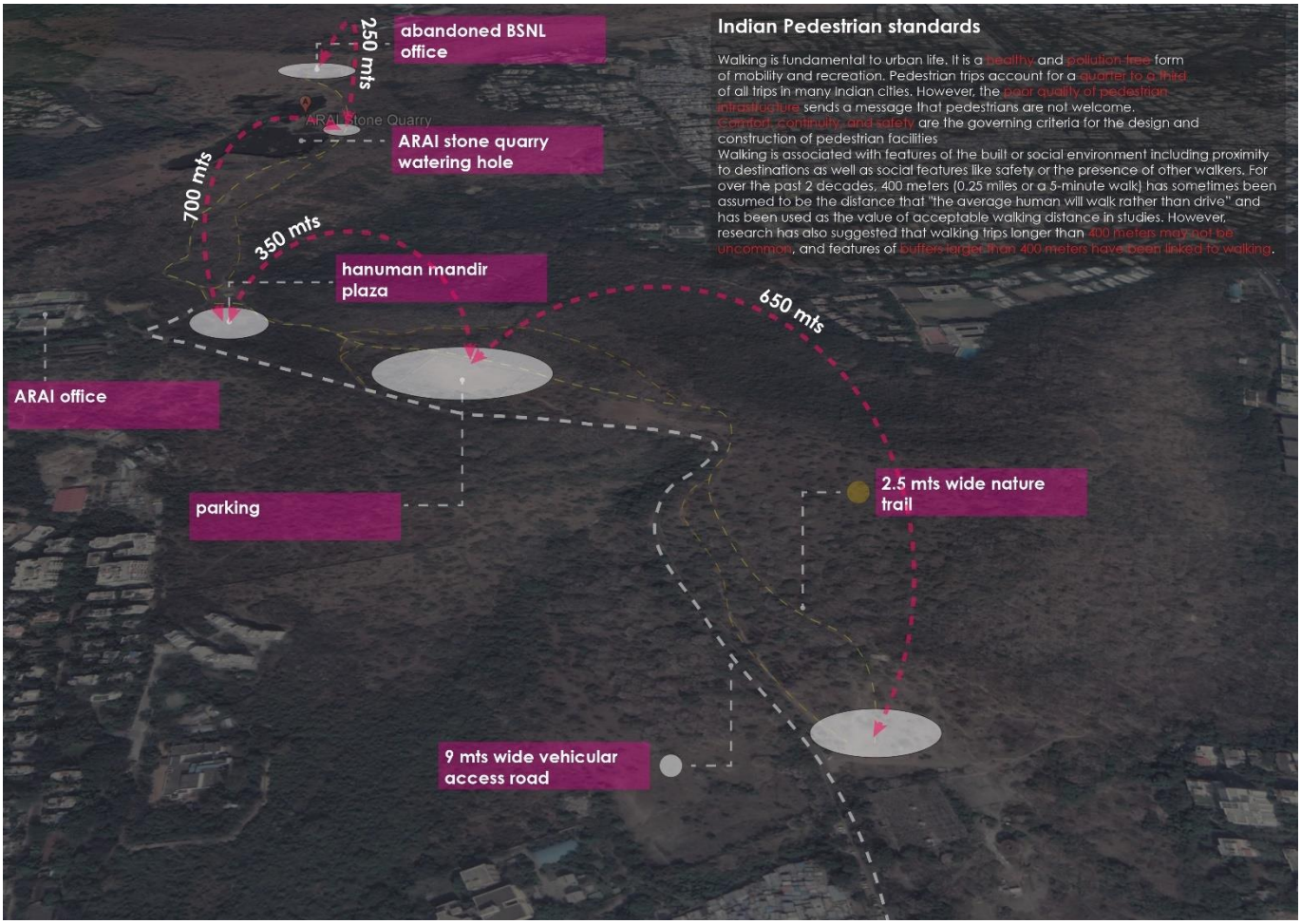


Fig 15 – Pedestrian distances between the existing features and Pause points around ARAI Stone Quarry and Nature Trail

14.2 CLIMATE ANALYSIS OF ARAI STONE QUARRY NATURE TRAIL

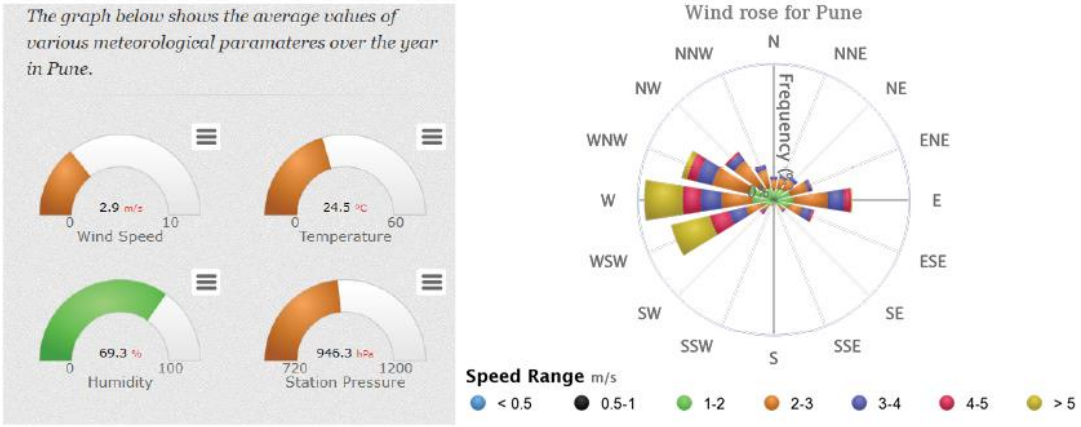


Fig 16 – Meteorological parameters and Wind rose for Pune

Source - www.indianclimate.com

The average wind speed in Pune is 2.9 m/s with the maximum wind speed of around 10 m/s. The average ambient temperature remains 24.5°C, varies from 11°C to 37.2°C. The average reletive humidity remains around 69.3%, varies from 19.9% to 99.3%. The station pressure varies from 946 hPa to 936 hPa, averaged around 956 hPa. Windrose of Pune shows that predominantly wind blow from the W - about 18.14% of all wind directions.

Rainfall: Medium rainfall,

Annual rainfall - 600 mm

Height of Vetal tekdi: 262 mts from its base

Soil type: Red and medium black soil.

Medium black alluvial soil

Existing vegetation: Open scrub with small areas of forest

Slope: Varying slope ranging from 0 - 45%

Pune has composite moderate climate which is **hot dry and wet dry**.

Rock type: Basalt, a common extrusive volcanic rock, black and grey in colour.

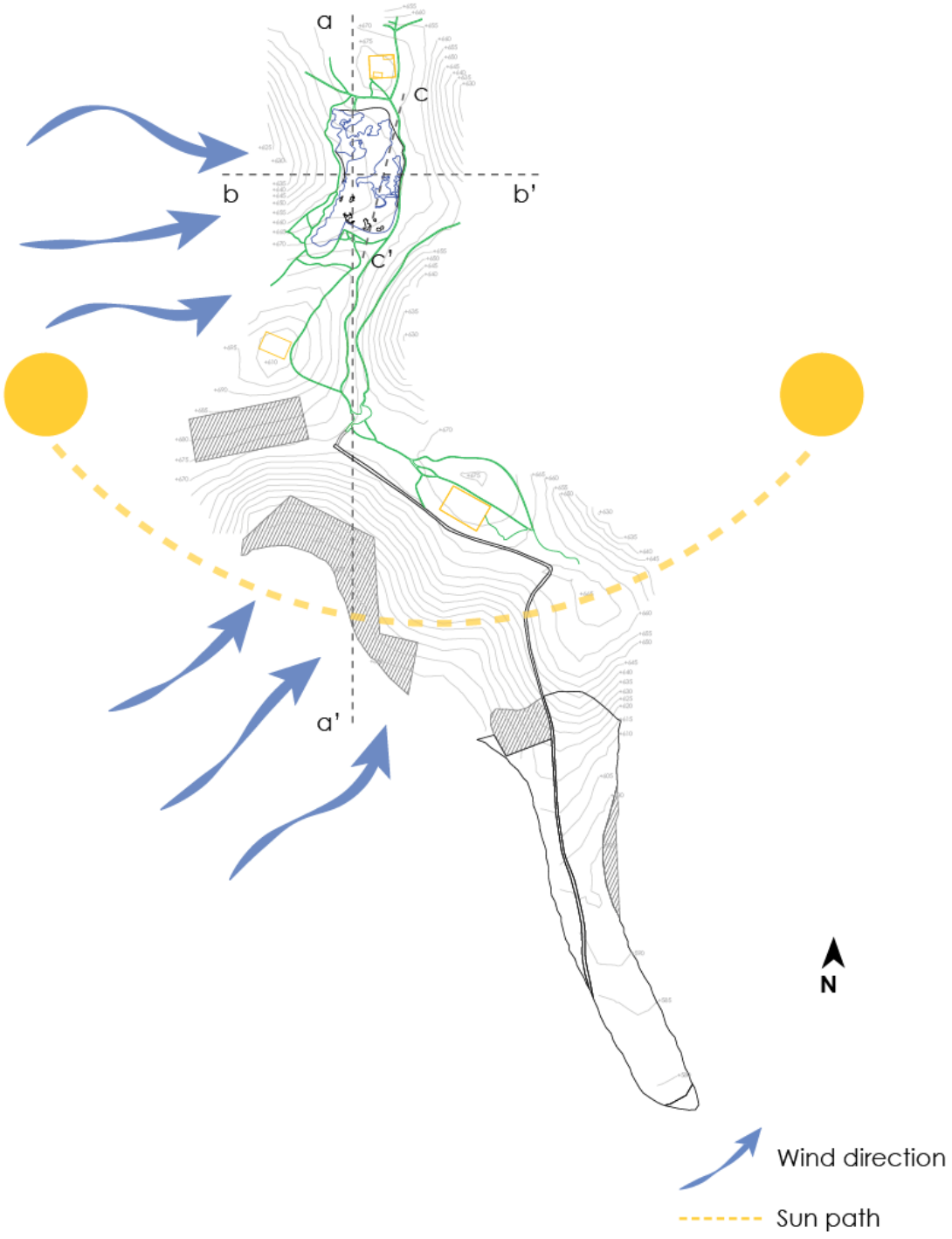


Fig 17 – Sun Path and Wind direction of ARAI Stone Quarry, Pune

15.0 SITE ANALYSIS OF ARAI STONE QUARRY NATURE TRAIL

15.1 SLOPE ANALYSIS OF ARAI STONE QUARRY NATURE TRAIL

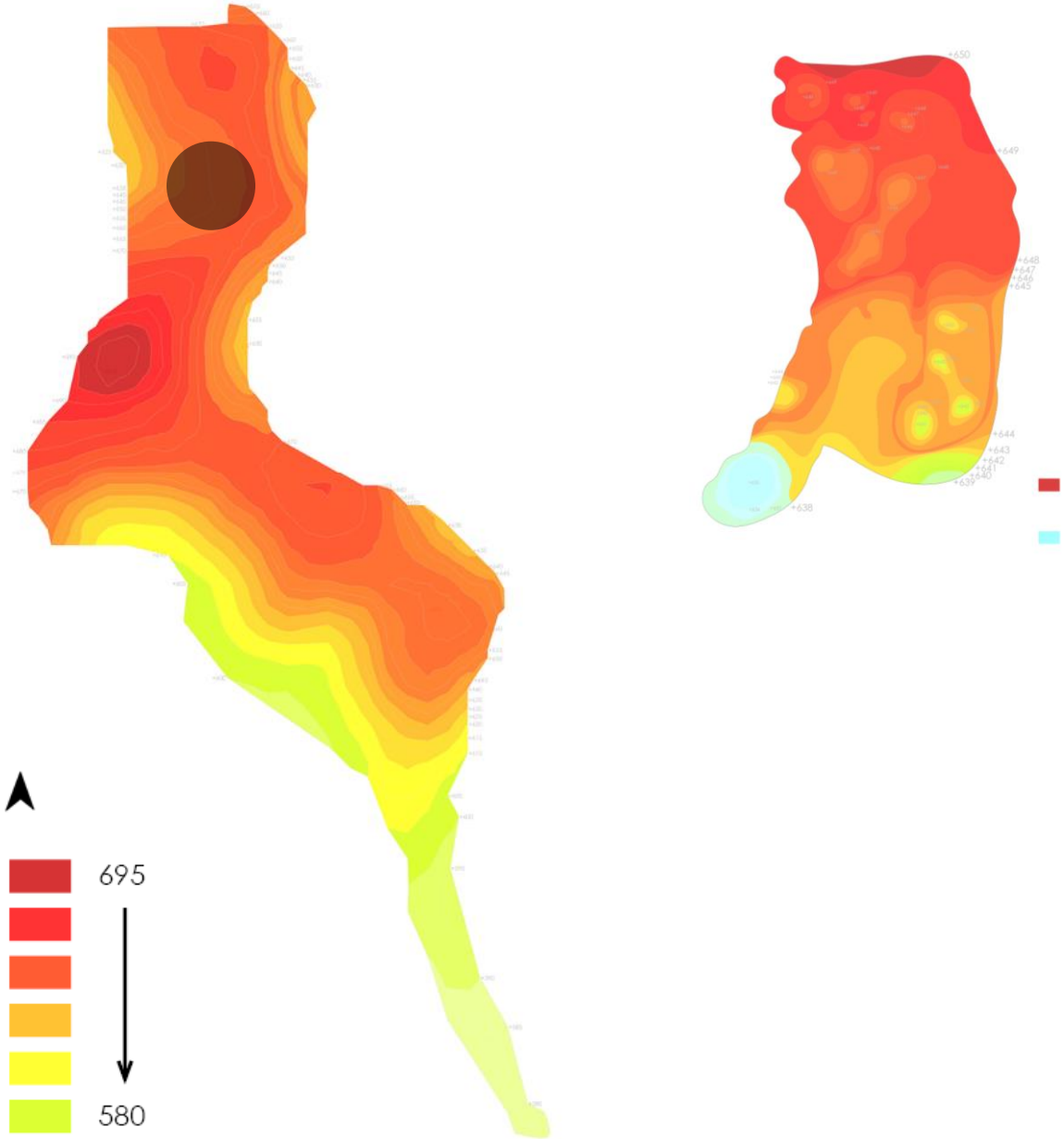


Fig 18 – Slope analysis of

L – ARAI Nature Trail, R – ARAI Stone quarry watering hole

15.2 HYDROLOGY ANALYSIS OF ARAI STONE QUARRY NATURE TRAIL

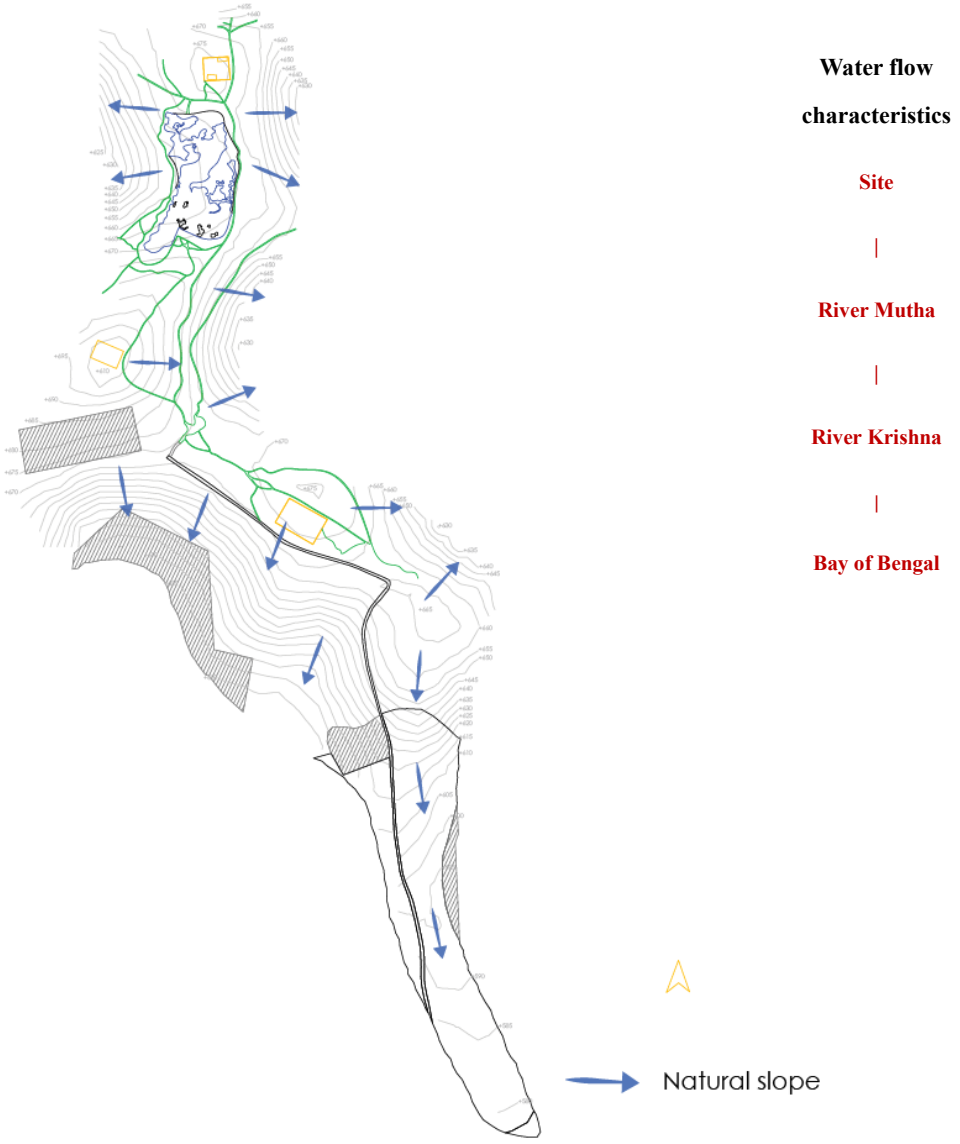


Fig 18 – Hydrology analysis of ARAI Nature trail

Hydrology analysis of the ARAI Stone Quarry Watering Hole

Catchment area **– 9.5 ha**

Submergence area **– 33,000 sq mts**

Annual rainfall of Pune – **760 mm**

Max daily rainfall intensity – **150 mm/ day**

Water holding capacity – **1,25,000 cum**

Possible HFL – **0.3 m above the 1.2 m wall top**

15.2 HYDROLOGY ANALYSIS OF ARAI STONE QUARRY NATURE TRAIL

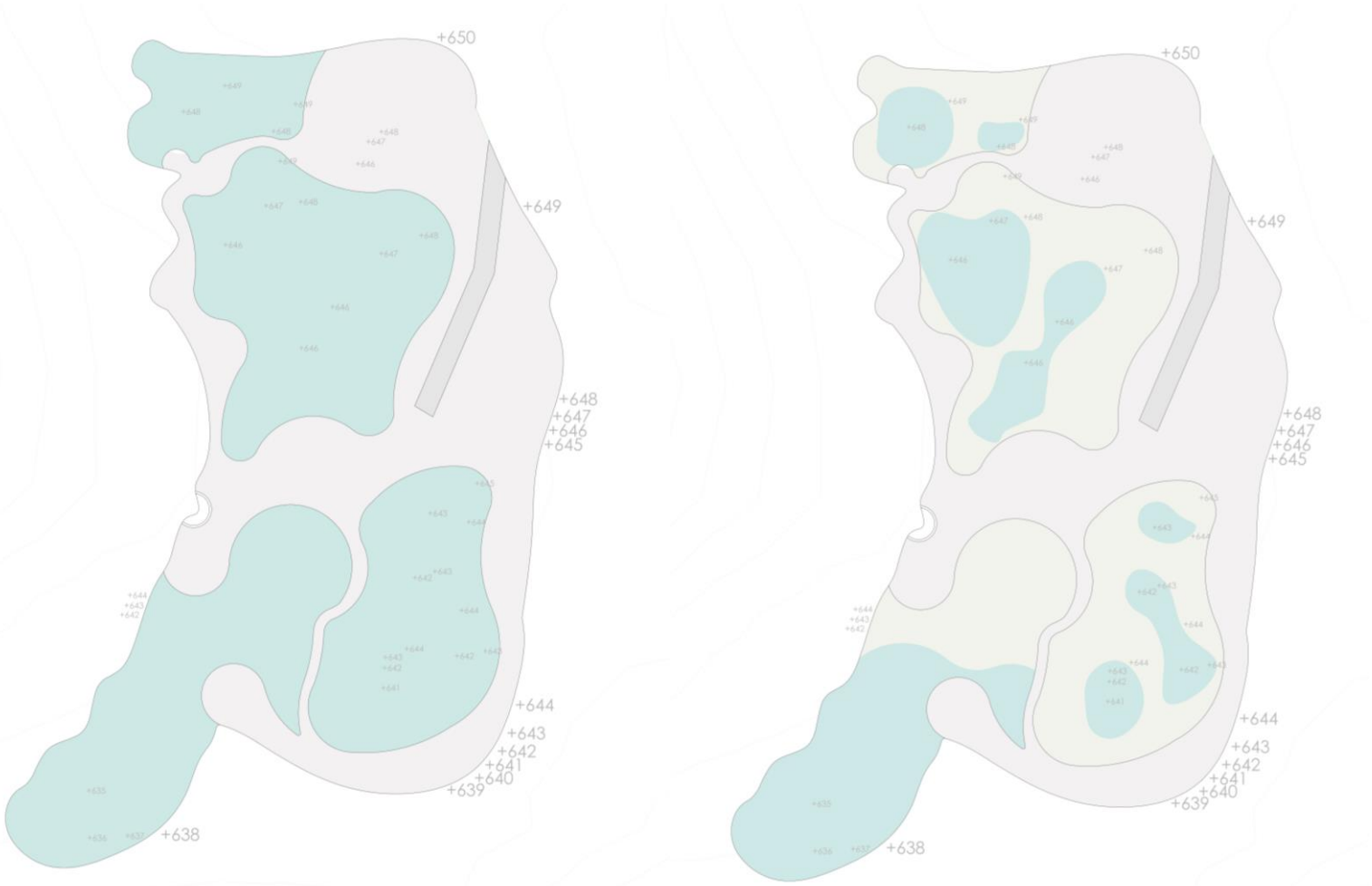


Fig 18 – Water Catchments in the ARAI Stone Quarry Watering Hole

L- Water catchment in Rainy Season in the ARAI Stone Quarry Watering Hole

R- Water catchment in Summer Season in the ARAI Stone Quarry Watering Hole

16.0 PROPOSED DESIGN BRIEF FOR INTERVENTIONS IN ARAI NATURE TRAIL AND WATERING HOLE

Space Program and Area Specifications

	Spaces	nos	Built up area (Sq. mts.)	Open area (Sq. mts.)
I	**Information centre**		**150**	
	Admin area		25	
	Waiting area		40	
	Ticketing counter		10	
	General information centre		15	
	Help desk			
	Storage room		15	
	Toilets		as req	
	First aid room		15	
II	**Nature interpretation centre**		**2050**	
A	**Admin area**		200	
1	Information vestibule			
2	Reception/ help desk, waiting			
3	Cloak room			
4	Management office			
5	Souvenir shop			
6	Toilets			
7	Watchman's cabin			
B	**Display area**			
1	Covered galleries	2	500	
2	Semi - open galleries		350	
3	Storage room		25	
4	repair and maintenance		25	
C	**Café**		75	
1	Coupon counter		20	
2	Semi - open seating area		200	
3	Kitchen		100	
4	Storage + cold storage			
D	**Research facility**			
1	Research labs	2	300	
2	Library and reading area		75	
3	Training/ Sensitisation studios	2	200	

III	**Yoga and meditation**		**1150**
1	Yoga pavilion		400
2	Yoga pavilion - semi-open		150
3	Meditative spaces		300
4	Contemplative gallery		300
IV	**Art and photography pavilions**		**1000**
1	Admin		
	Reception/ help desk, waiting		
	Cloak room		
	Management office		
	Toilets		
2	Exhibition space		
3	Citizen's pavilion		
	Human library		
V	**Toilet block and locker rooms**		**500**
1	Rope pavilion		
2	Toilet block and locker rooms		
VI	**Bird watching points**	**5**	**150**
	Toilet blocks along the trail	3	150
	Total built-up area		**5000**

VIII	**Parking - 1 information centre**		
	2 wheeler	20	
	4 wheeler	10	
	Cycles	30	
IX	**Parking - 2 Nature interpretation centre**		
	2 wheeler	20	
	4 wheeler	10	
	Cycles	30	
X	**Parking - 3 Hanuman mandir plaza**		
	2 wheeler	20	
	4 wheeler	10	
	Cycles	30	
	Help desk		
	Watchman's cabin		
XI	**ARAI Stone Quarry watering hole**		
A	Pisciculture		7100 (1.75 acres)
	Information centre		
	Fishing decks	5	
B	Adventure sports		3750
	Rock climbing, Rappelling		
C	Sculptural Park and butterfly park		9750
D	Water chestnuts and lotus plantations		8500

16.1 PROPOSED ZONING AND CONCEPT

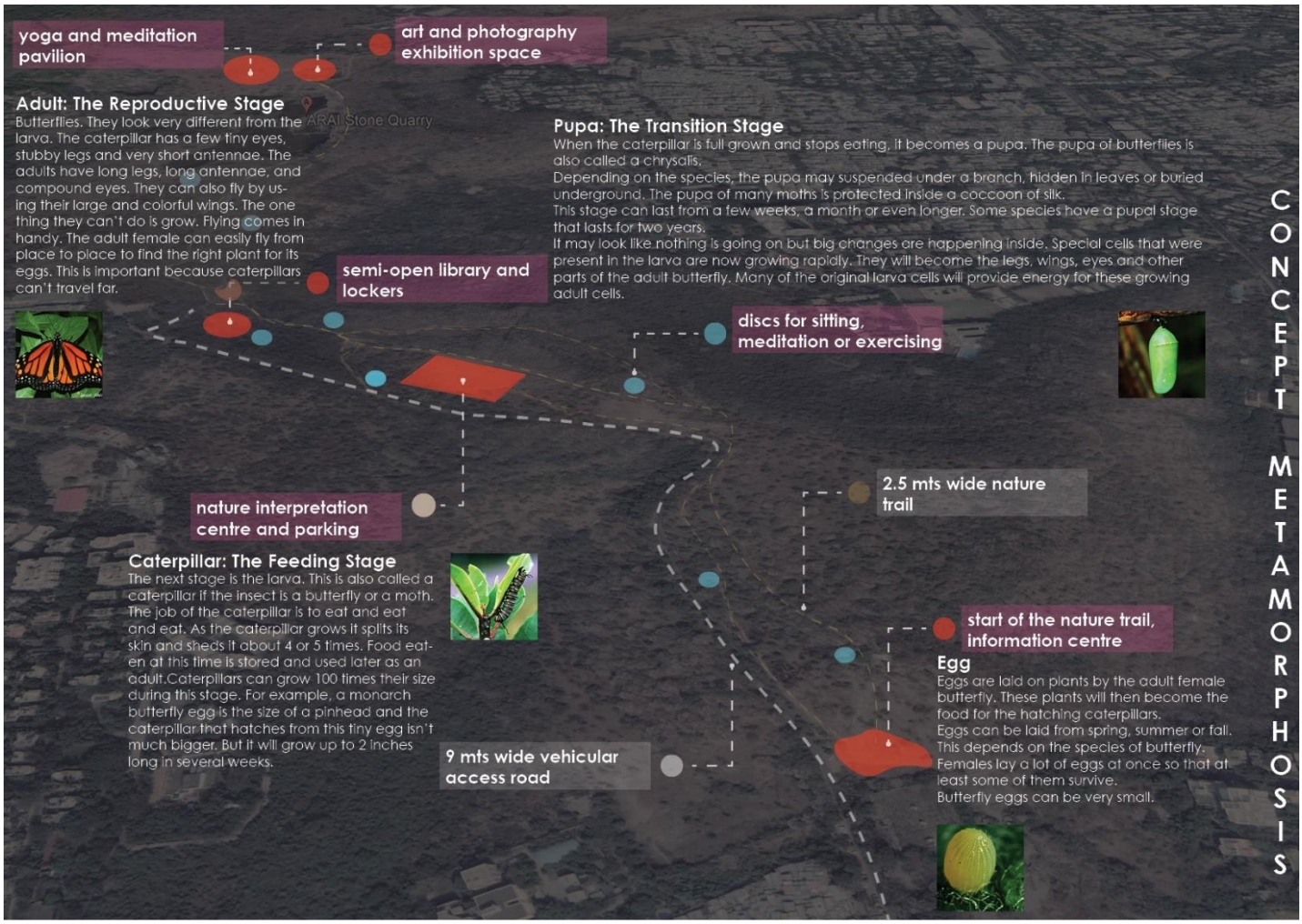


Fig 19 –

Upper - Proposed zoning along the ARAI Nature Trail

Lower – Metamorphosis Concept illustration

16.2 BENEFITS OF THE PROJECT

- Effective utilization of abandoned quarries
- Water conservation
- Development of Pisciculture
- Creating awareness about nature conservation among citizens
- Growth of medicinal plants
- Space for students for their research in nature conservation area
- Invitation for migratory birds
- Revenue model for authorities

16.3 CHALLENGES OF THE PROJECT

- Erosion control
- Stabilization of dump slopes.
- Developing alternative use of abandoned mine pits.
- Ecological restoration. Top soil conservation.

16.4 STAKEHOLDERS

- Owner Forest Department
- Daily Commuters
- Nature Conservationists NGOs
- Construction team
- Fishery Department
- Fishing Agency
- Investor
- Adventure sports agency
- Event Management team

17.0 CONCEPT OF BIODIVERSITY PARKS

Biodiversity Parks are unique landscapes/ riverscapes of wilderness where ecological assemblages of native species are recreated over marginal/ degraded landscapes/ riverscapes. Biodiversity Parks are based on the ecological restoration principle and the underlying principle is to establish self-sustaining ecosystems that have biodiversity and function that generate ecological services that contribute to well-being of humans.

The Biodiversity Park approach is innovative approach or model for recreation of lost biodiversity or natural heritage and it is a conservation approach. It involves conservation of ecosystems, communities, species, populations, and simulate National Parks/ Wildlife Sanctuaries/ Nature Reserves/ Wilderness. (Babu, June 2020)

17.1 FUNCTIONS OF BIODIVERSITY PARKS

Biodiversity Parks have wide range of functions and encompass almost all the four categories of ecosystem services rendered by ecosystems, and include:

(i) Enrich human microbiome as the parks harbour rich environmental microbiome, and this in turn reduces the human health risks and public health burden;
(ii) Serve as filters for point and nonpoint source of air pollutants;
(iii) Store flood water and recharge ground water;
(iv) Prevent soil erosion and stabilize floodplains;
(v) Reduce flood water velocity;
(vi) Serve as hub for conservation, educational and cultural activities;
(vii) Promote ecotourism;
(viii) Connect the city and its citizens to nature and biodiversity;
(ix) Provide livelihoods to local communities;
(x) Serve as living museum for understanding ecosystem processes and function; (xi) sequester CO2 and impart climate resilience, buffer local weather and even cause local precipitation;
(xi) Serve as habitat for vanishing flora and fauna
(xii) Purify water,
(xiii) Enhance biological productivity ,
(xiv) Sustain river ecosystem and
(xv) Rejuvenate rivers. (Babu, June 2020)

17.2 STRUCTURAL COMPONENTS OF BIODIVERSITY PARKS

A Biodiversity Park can have wide range of landscape/ riverscape elements, and it depends upon the space availability, nature of the ecosystems that used to exist before degradation, topography of the area and what the local communities need, besides the main goal of bringing back the lost pristine glory of the landscape/ riverscape and rejuvenation of rivers. An ideal Biodiversity Park has two zones – (i) the Nature conservation zone and (ii) the visitor zone. The nature conservation zone consists of terrestrial and aquatic ecosystems of the area where the natural forest ecosystems, floodplain wetlands, forests and grasslands, river channels and their interconnections with wetlands of floodplains are located. The visitor zone will have a number of elements such as representative ecosystems of the area, a herbal garden, an aquatic garden to preserve the aquatic resources, wetlands, butterfly conservatory, green ways along the embankment, diverse wetlands that attract diverse group of birds, NIC, constructed wetlands for treatment of wastewater, natural bathing sites for local community on specific festivals and Recreational Parks.

The Biodiversity Parks of riverscapes can have the following structural components:

(i) Forest communities along the river embankment and adjacent upland.

(ii) Greenways with walkways and cycleways long the river embankment/ bunds. The greenways have 3-storeyed native forest communities.

(iii) Greenways with Recreational Parks, where human settlements are located close to the river.

(iv) Floodplain forests and grasslands, marshes, wetlands and lakes on floodplains.

(v) A butterfly conservatory, an herbal garden, a recreational park and forest communities on elevated floodplains.

(vi) An NIC on the elevated floodplains/ embankment/ upland

(vii) Representative riparian ecosystems along the channel banks and riverbeds.

(viii) Natural bathing sites for local communities.

(ix) Natural treatment wetlands for cleaning of river water.

(x) Constructed wetlands for treatment of wastewater that enters into river.

(xi) An aquatic garden for conservation of aquatic flora. (Babu, June 2020)

17.3 DEVELOPMENT OF BUTTERFLY PARK

This should be developed on upland /embankment, and suitably landscaped. About 70-100 host plants for larvae and 70-100 flowering shrubs and trees that produce nectar bearing flowers and serve as host plants for adult butterflies should be planted. About 50-100 species of butterfly species will be attracted to the Butterfly Park. The area required for development of Butterfly Park is about 2 to 5 acres.

There should be 2-3 small shallow waterbodies scattered over the area. Each waterbody should be 10 m X 10 m and 1 m depth. This is needed for maintaining relative humidity.

There should be shelter belt around the periphery of Butterfly Park with 1 or 2 rows of bamboo. (Babu, June 2020)

17.4 DEVELOPMENT OF HERBAL GARDEN

An area of 5-8 acres in the upland/ elevated floodplains can be developed into a herbal garden. Plants that can be used in home remedies can be grown and can be provided to local communities. About 100-150 species of local plants of medicinal value can be grown.

The area should be suitably landscaped depending on the site characteristics. (Babu, June 2020)

17.5 DEVELOPMENT OF FRUIT YEILDING GARDEN

A fruit yielding plant garden can also be developed along embankment/ upland. About 25-30 acres can be used for the development of local varieties of popular fruit yielding species in the region. (Babu, June 2020)

17.6 BIRDING AREA

Besides cultivated fruit bearing plant garden, wild shrubs and trees bearing fresh fruits should also be planted to attract birds. This should be designated as Birding Area. This should be located over an area of 25 -30 acres in upland.

(Babu, June 2020)

17.7 NATURE INTERPRETATION CENTRE

A Nature Interpretation centre is critical in a Biodiversity Park. It serves as a tool for promoting awareness among public and students on the need for river conservation and sustenance of river ecosystems to sustain water quantity and quality.

A modest building (aesthetically designed with built up area of 10,000-15,000 sq. ft. is adequate enough. It should have Toilets and a small Seminar Room where visitors can sit to discuss the issues relating to river ecology and management. An office complex of 5000 sq. ft. and a minor laboratory of 5000 sq. ft. may be attached to NIC. This complex should be developed in the upland area.

A recreational garden should be developed in and around NIC. The area required will be 1 to 2 acres. The area should be suitably landscaped.

A network of trails connecting different structural elements of Biodiversity Park should be developed. The width of major trails should be 8' wide and secondary trails connecting major trails should be 6' wide and tertiary trails that connect secondary trails should be 4' wide. This network of trails should pass crisscross way across the riverscape. No concretization of trails should be permitted; No paver blocks should be used.

A field vehicle, a tractor and a golf cart are essential for the Park. (Babu, June 2020)

17.8 MANAGEMENT COMMITTEE

A management committee consisting of senior representatives of Irrigation Department (Chief Engineer), Forest Department (Conservator of Forest of the concerned Division), Department of Fisheries (senior officer), Department of Tourism (senior officer), State Pollution Control Board (regional officer) and representative from the Municipal Corporation/ Village Panchayat should be constituted to oversee the development of Biodiversity Parks.

(Babu, June 2020)

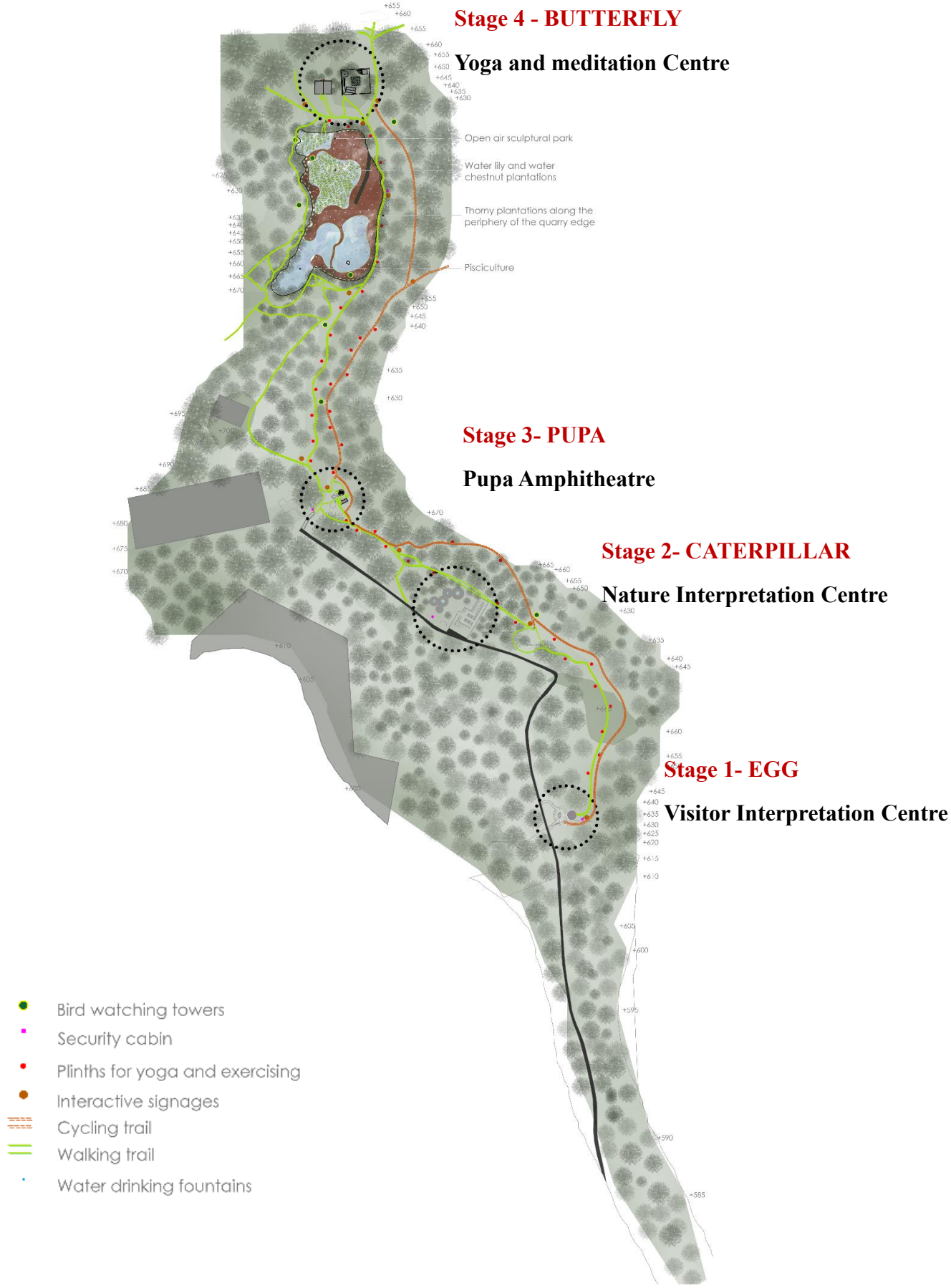


Fig 20 – Proposed Site plan

18.0 PROPOSED DESIGN OF THE QUARRY

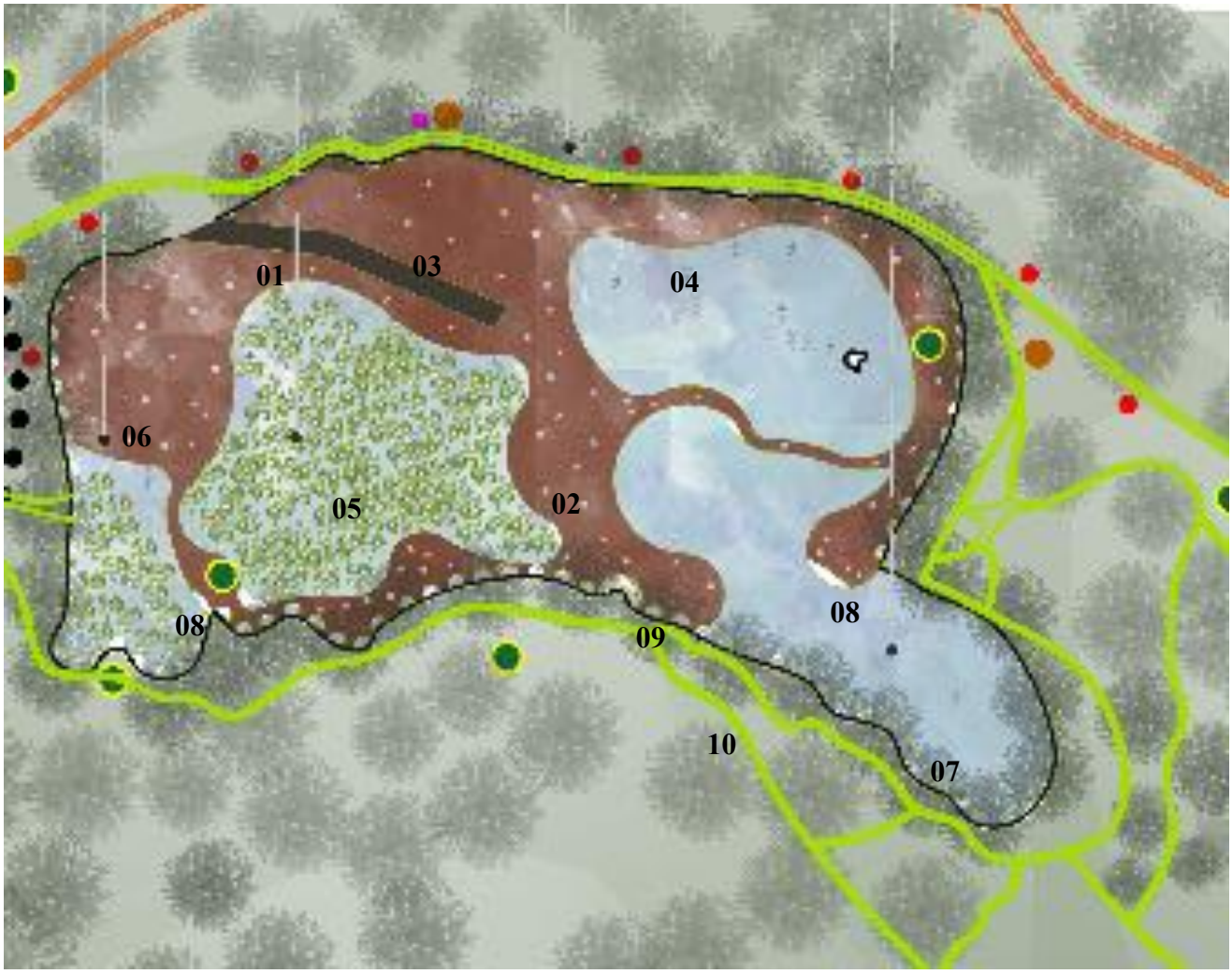


Fig 21 – Proposed plan of the Quarry Watering Hole

LEGEND

01 Entry ramp leading to the quarry

02 Information pavilion

03 Herbal garden

04 Rock climbing activities

05 Water lily and water chestnut plantations

06 Open air sculpture park and butterfly garden

07 Pisciculture

08 Decks for fishing

09 1.2 mt wall to avoid water to drain away

10 Thorny plantation on edge

18.1 PROPOSED VIEWS OF THE QUARRY WATERING HOLE

01

Entry ramp leading to the quarry

02

Information pavilion and water lily and lotus plantations

03

Open air sculpture park and butterfly garden

03

Open air sculpture park and butterfly garden

04

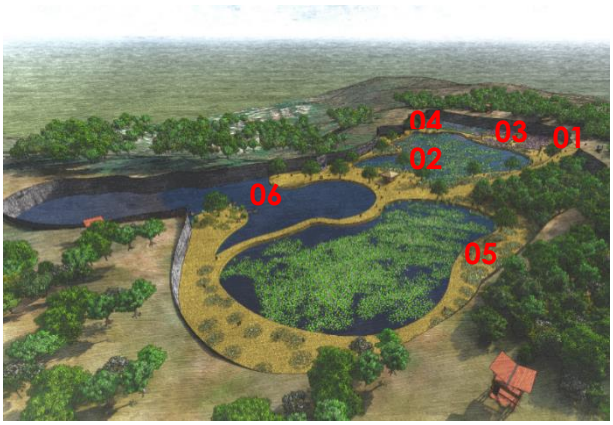
Bird watching blinds

05

Herbal garden and rock-climbing activities

06

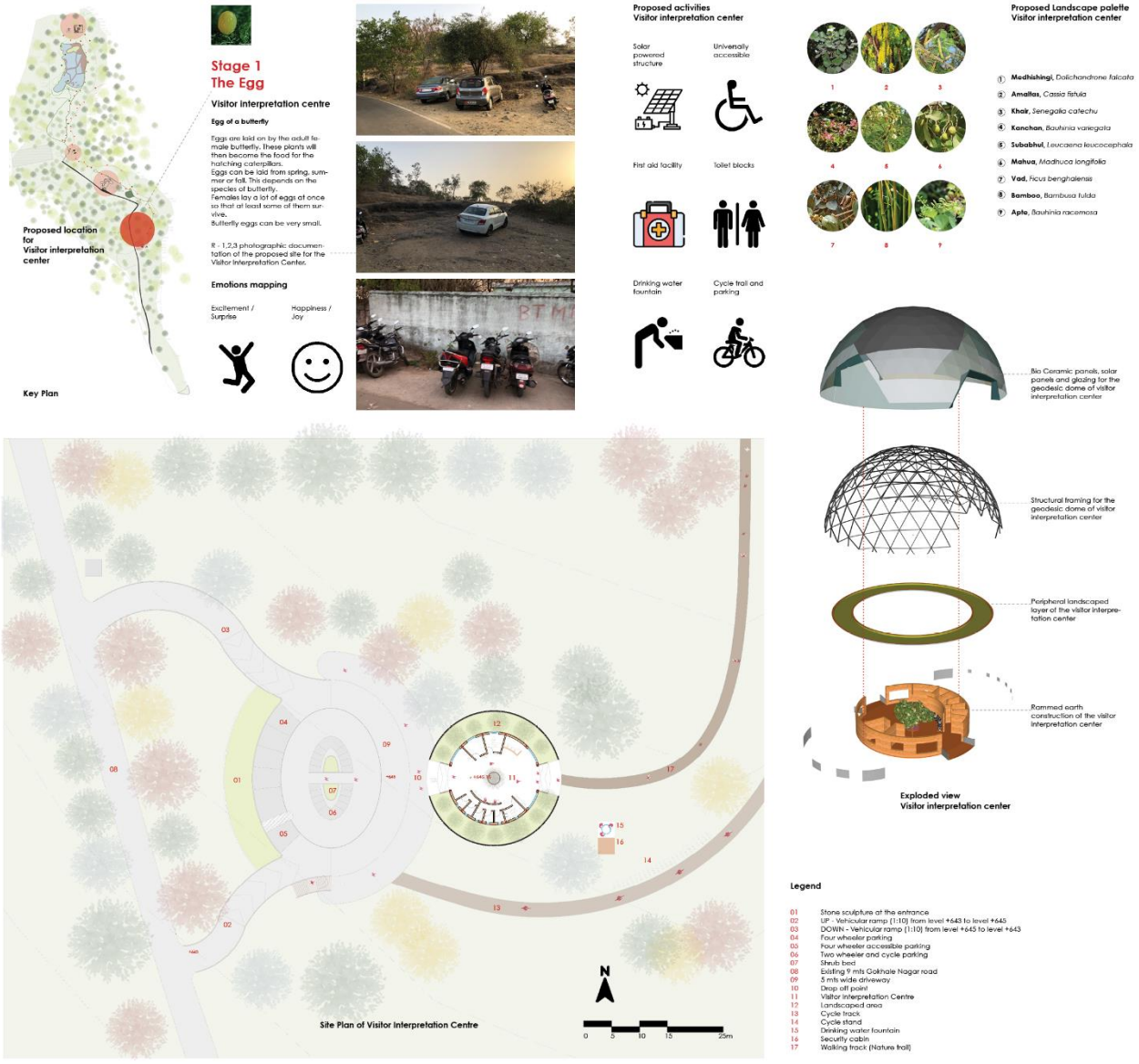
Decks for fishing (Pisciculture)



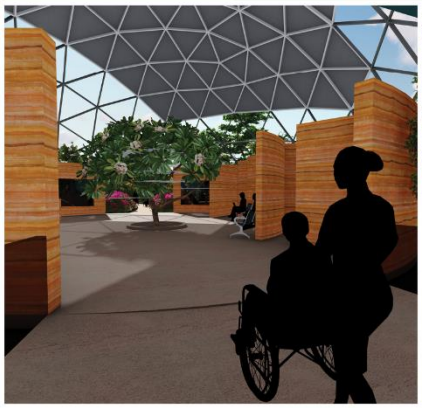
Aerial view of the quarry

Fig 22 – Proposed 3D views of the Quarry Watering Hole

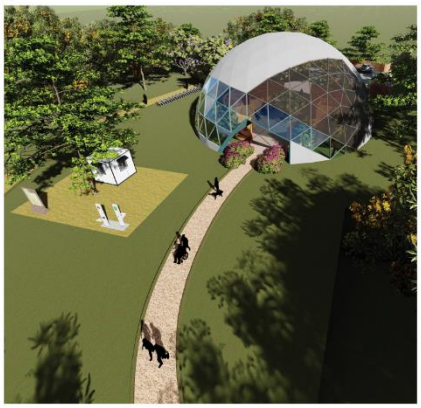
18.2 PROPOSED DESIGN OF THE VISITOR INTERPRETATION CENTRE



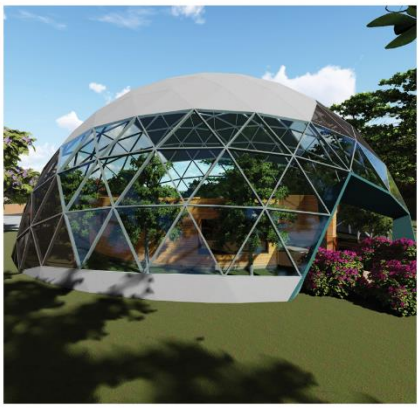
Areal view of the Visitor Interpretation Centre



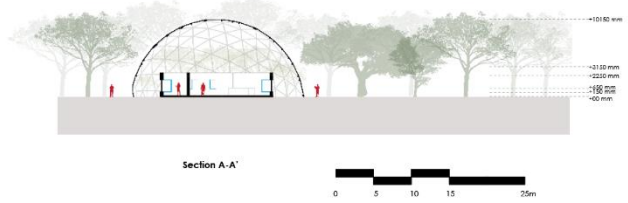
View of the entrance and interior of the Visitor Interpretation Centre



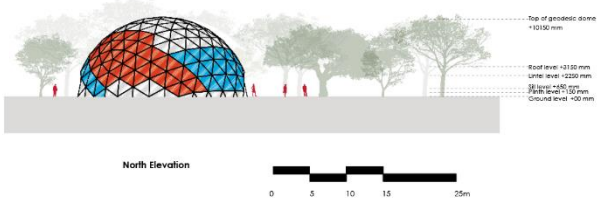
Areal view of the Visitor Interpretation Centre showing trails and drinking water fountain



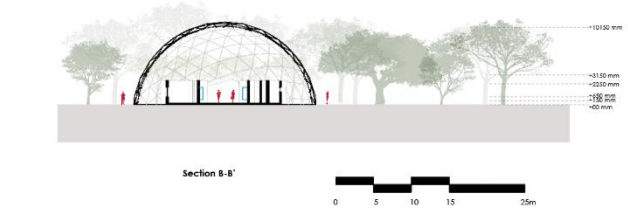
View of the Visitor Interpretation Centre



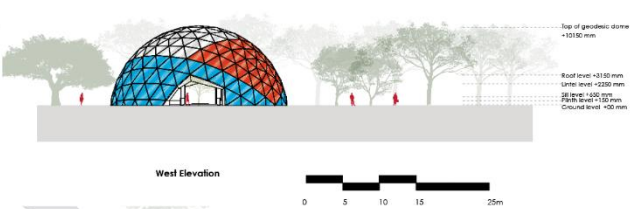
Section A-A'



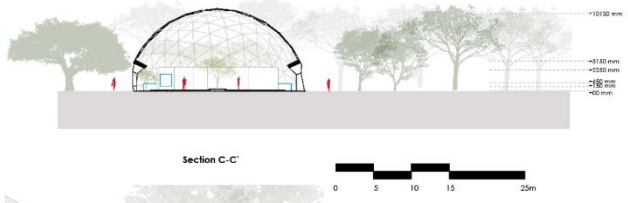
North Elevation



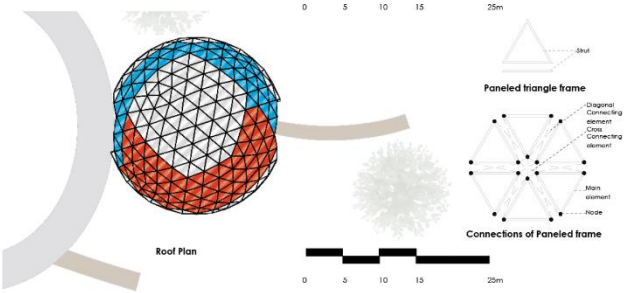
Section B-B'



West Elevation



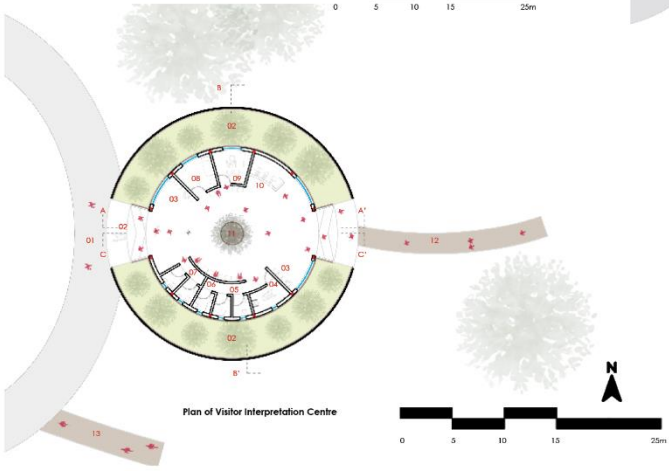
Section C-C'



Roof Plan

Paneled triangle frame

Connections of Paneled frame



Plan of Visitor Interpretation Centre

Bio-ceramic Panel detail

Low embodied energy 98% less than a conventional house made of wood

Insect resistant Ceramic is desiccant, it dries out on insects

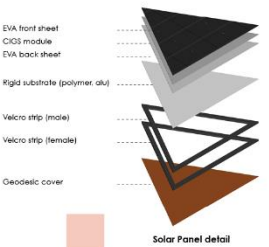
Water proof Ceramic is impervious to water.

Fire resistant Ceramic withstands 2700F

Low maintenance No roofing, paint, siding to replace

Legend

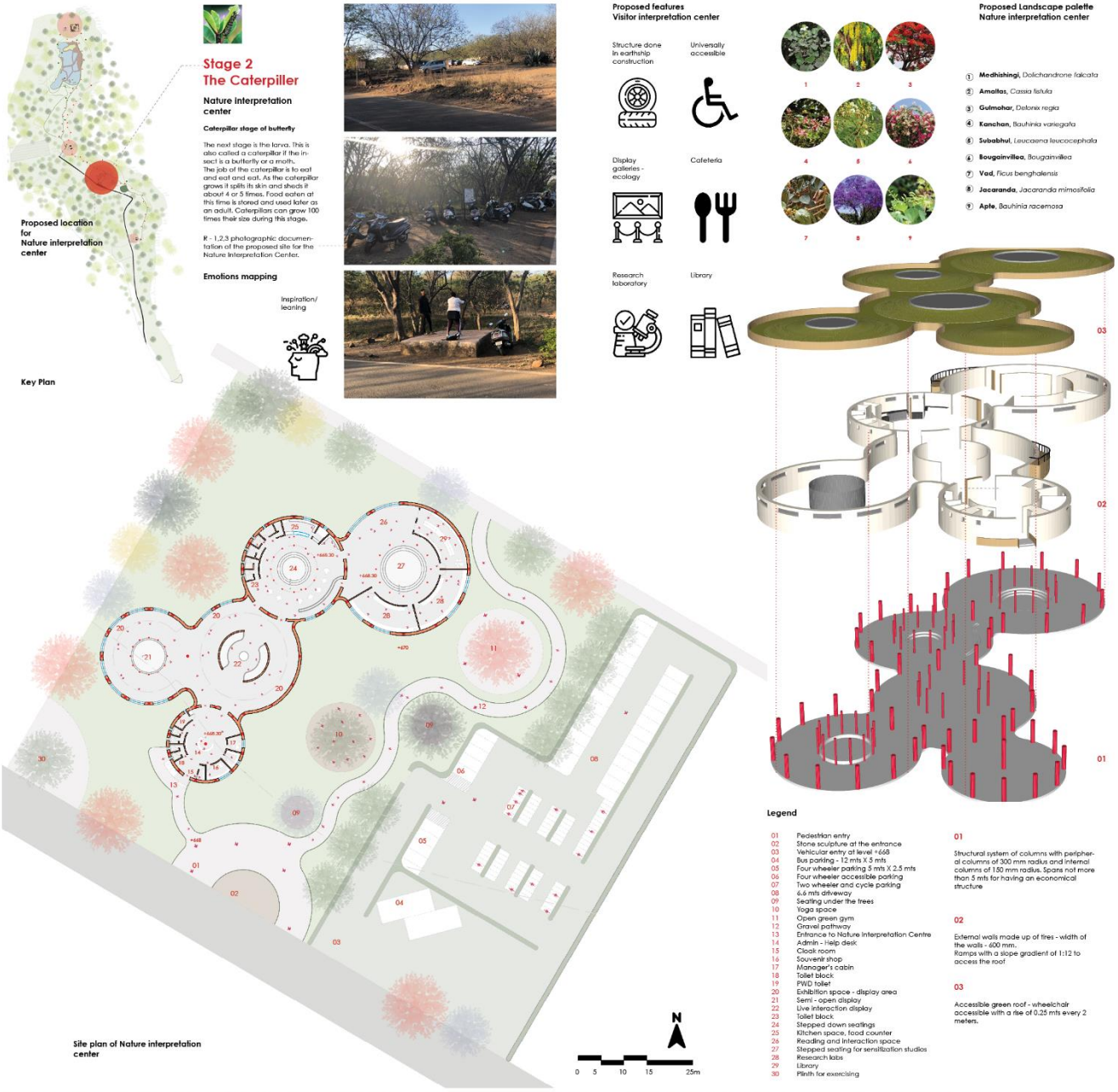
01 Entry to the Visitor Interpretation Centre - Drop off point
02 Up ramp (1:12)
03 Waiting area
04 PWD toilet
05 Ladies toilet
06 Janitor room
07 Gents toilet
08 First aid room
09 Manager's cabin
10 Help desk
11 Chapha tree
12 Walking trail leading one to the Nature interpretation center
13 Cycle trail
14 Landscaped area



EVA front sheet
CIGS module
EVA back sheet
Rigid substrate (polymer, alu)
Velcro strip (male)
Velcro strip (female)
Geodesic cover

Solar Panel detail

18.3 PROPOSED DESIGN OF THE NATURE INTERPRETATION CENTRE

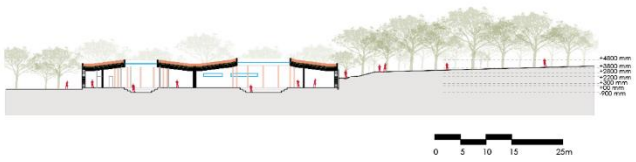


Areal view of the Nature Interpretation Centre

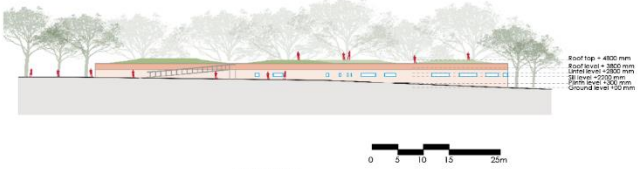
Interior view of the display galleries of the Nature Interpretation Centre

Areal view of the Nature Interpretation Centre showing the green gym

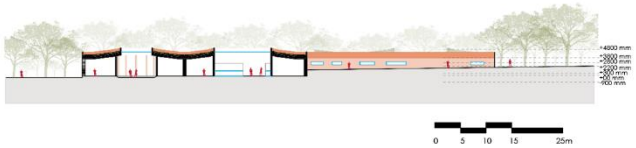
Areal view of the Nature Interpretation Centre showing the green roof



Section A-A'



West Elevation



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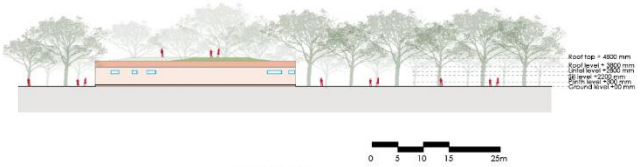
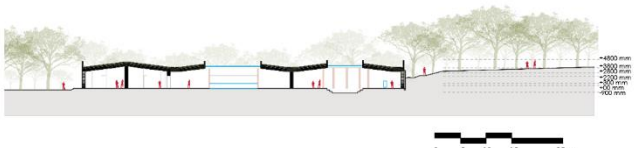
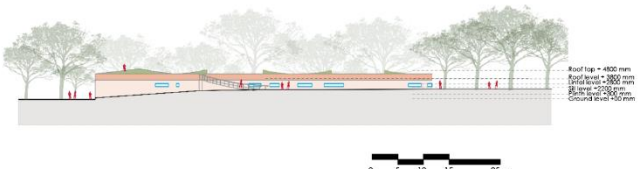


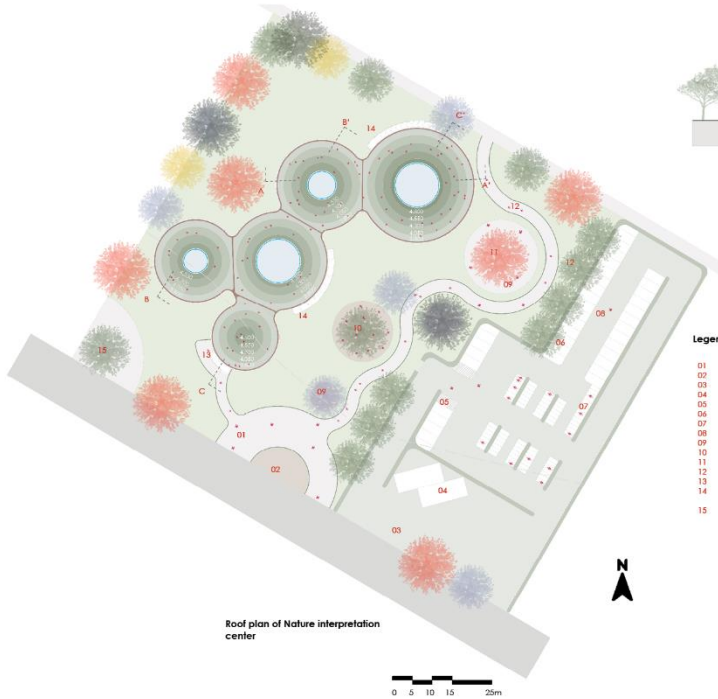
South Elevation



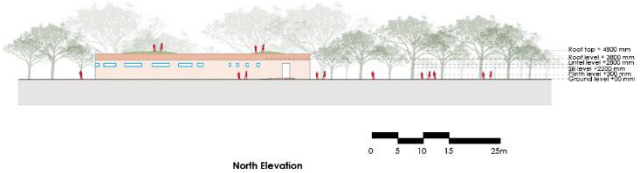
Section C-C'



East Elevation



Roof plan of Nature interpretation center



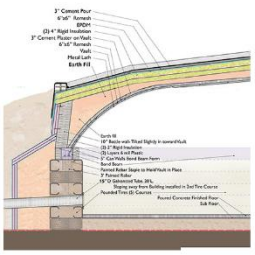
North Elevation

Earthship construction

Earthship construction building technique is considered for the design of nature interpretation centre as it is an extremely sustainable building methodology. Accessible green roof is just another attempt to make the structure more sustainable. The skylight and gutter details have been worked out accordinly and implemented in the sections and plans.
The structure is accessible to all the users.

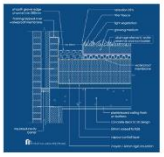
Legend

01 Pedestrian entry
02 Stone sculpture at the entrance
03 Vehicular entry at level +668
04 Bus parking - 12 mts X 3 mts
05 Four wheeler parking 3 mts X 2.5 mts
06 Four wheeler accessible parking
07 Two wheeler and cycle parking
08 6.6 mts driveway
09 Seating under the trees
10 Yoga space
11 Open green gym
12 Gravel pathway
13 Entrance to Nature Interpretation Centre
14 Up ramp - To access the green roof (gradient 1:12)
15 Plinth for exercising



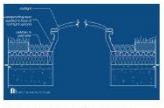
Typical section of earthship construction

Source - Earthship Biotecture



Typical section of a gravel gutter on a green roof

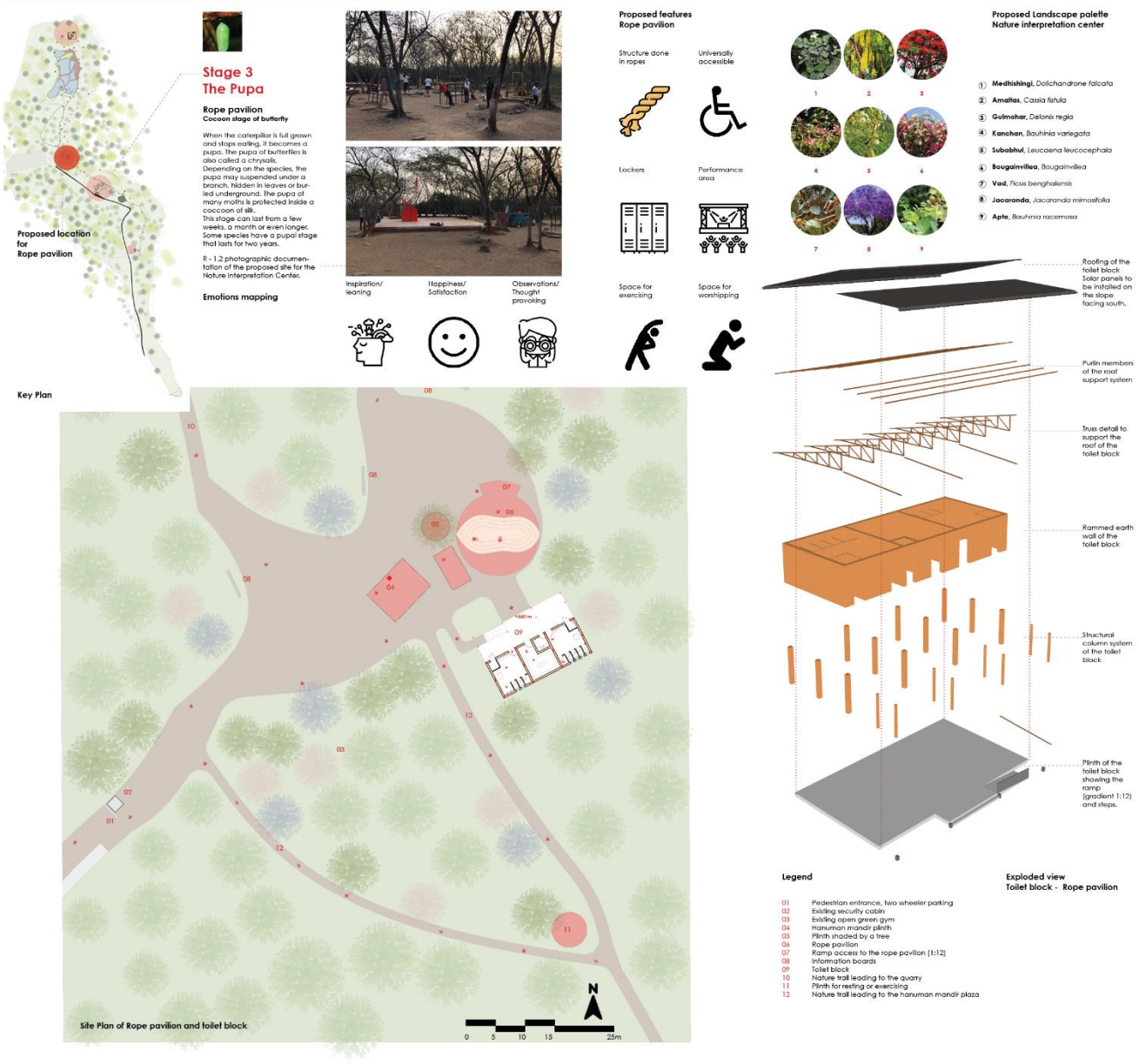
Source - www.forstinarchitecture.co.uk



Typical section of a skylight on a green roof

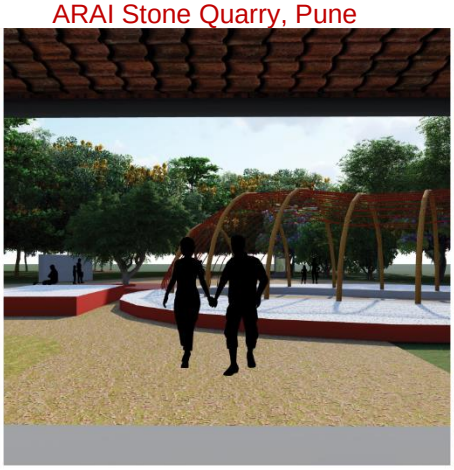
Source - www.forstinarchitecture.co.uk

18.4 PROPOSED DESIGN OF THE ROPE PAVILION AND TOILET BLOCK



Areal view of the Rope pavilion and Toilet blocks

View of the rope pavilion, the existing plinths and the cycle track



View of the rope pavilion, the existing plinths from the toilet block

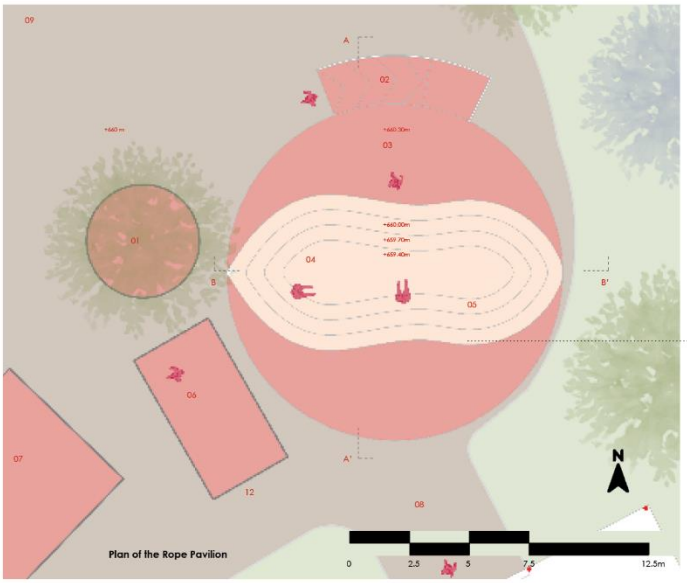
Areal view of the rope pavilion showing the plinths, exercising space and the toilet block

East Elevation

Section A-A'

South Elevation

Section B-B'



Plan of the Rope Pavilion

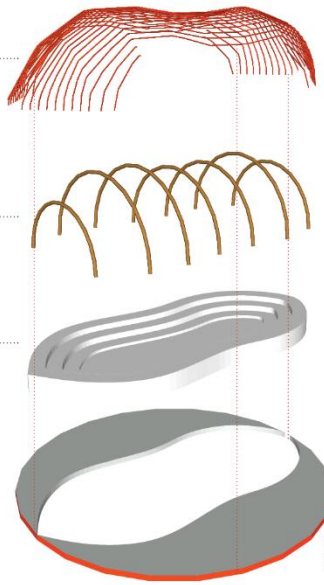
Semi open roofing of the pavilion done in ropes painted in red colour to match the context of red coloured plinths. The purpose of using ropes is to imitate the structure of a cocoon.

Base frame made up of bamboo with 150 mm diameter. Bamboo attached to the plinth on steel base plates for structural stability

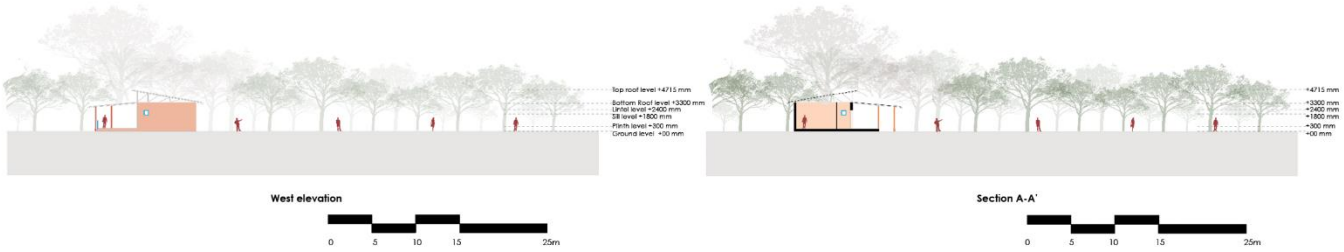
Stepped seating
Riser of each step - 300 mm
Treadof each step - 1000 mm
1500 Clear opening designed for this pavilion to be wheelchair friendly

Legend

01 Existing plinth 01
02 Ramp to access the plinth (1:12)
03 Space for interaction
04 Performance area
05 Stepped seatings
06 Existing plinth 02
07 Hanuman mandir plinth
08 Pathway leading to toilet block
09 Pathway leading to the quarry



Exploded 3 D view of the rope pavilion

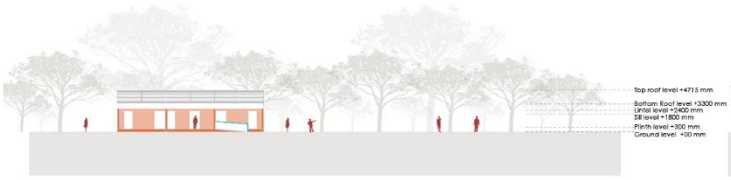


West elevation

0 5 10 15 25m

Section A-A'

0 5 10 15 25m



South elevation

0 5 10 15 25m

Section B-B'

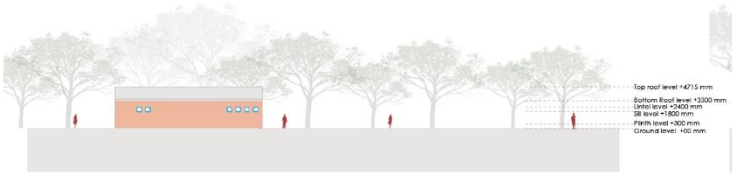
0 5 10 15 25m

East elevation

0 5 10 15 25m

Section C-C'

0 5 10 15 25m

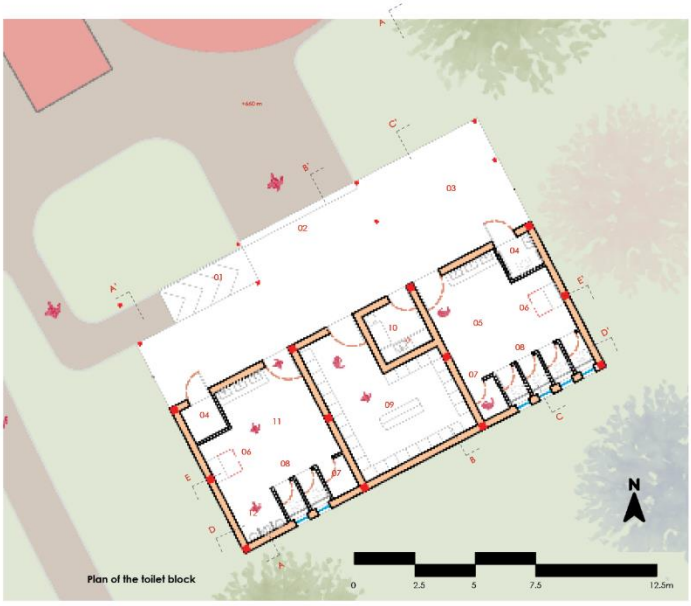


South elevation

0 5 10 15 25m

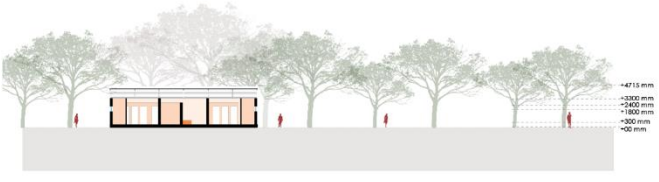
Section D-D'

0 5 10 15 25m



Plan of the toilet block

0 2.5 5 7.5 12.5m



Section E-E'

0 5 10 15 25m

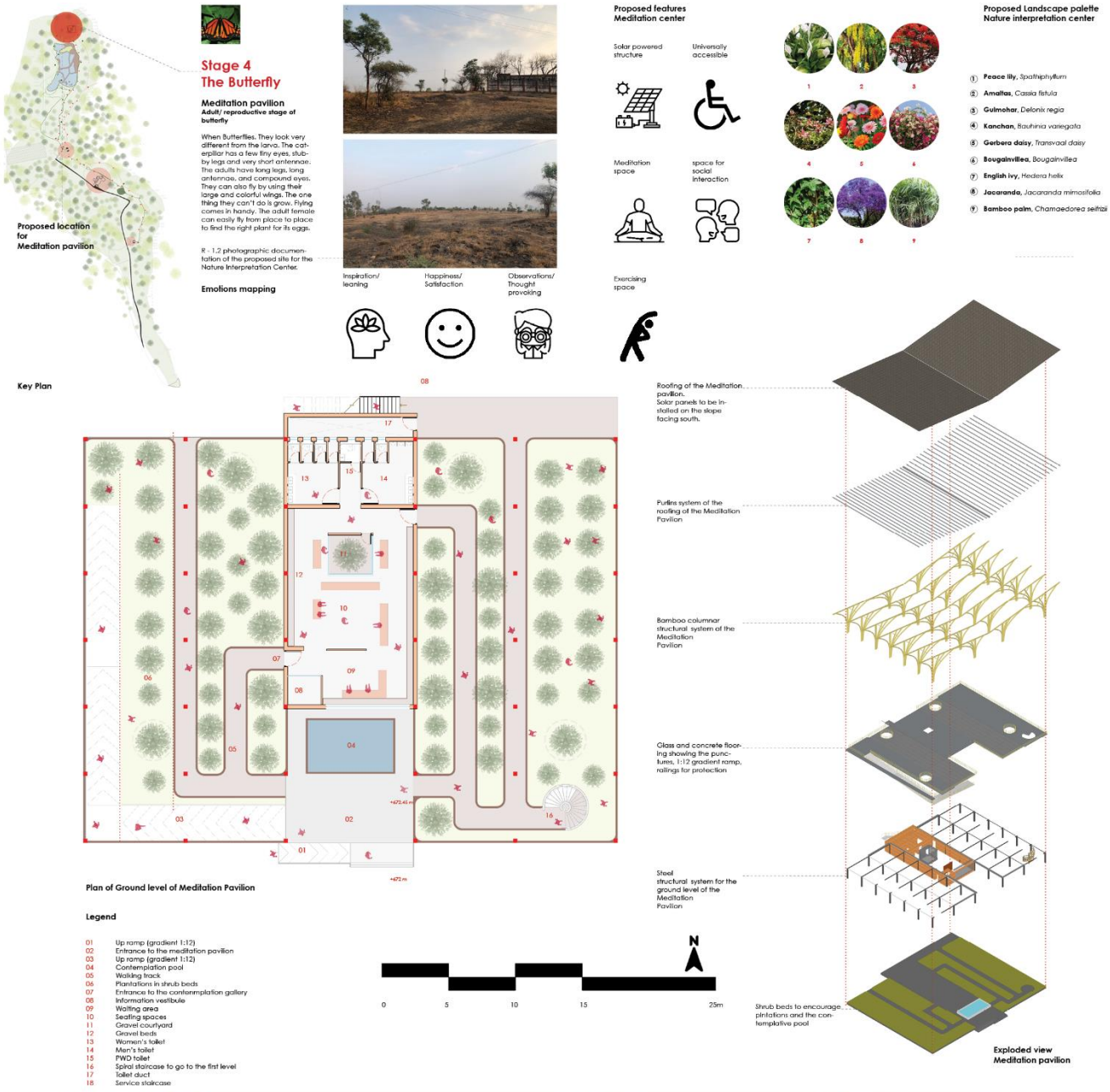
Legend

01 Up ramp (1:12)
02 Entrance to the toilet block
03 Space for interaction
04 PWD toilet
05 Ladies toilet
06 Diaper changing table
07 Janitor room
08 Toilet cubicles
09 Locker room
10 Baby care room
11 Men's toilet
12 Urinals

Eram's e-toilet flushes itself before, and after every use, with a minimum amount of water, that is determined through sensors. On an average, each flush uses 1.5 litres of water, compared to the 8-10 litres used by a normal flush. Its floor is automatically washed after every tenth use. The lights also turn on automatically and draw power from a built-in solar panel. Everything is monitored through GPRS telemetry: the frequency and volume of usage, and water and electricity consumption. Also, there are provisions for waste treatment using anaerobic biodegradation.
All these provisions help ensure that these energy-efficient toilets can be installed in locations where access to electricity and common sanitation methods is difficult, if not impossible. Also, while e-toilets may be more expensive than public toilets as they are built now in India, but most of the latter become defunct within months because of the lack of maintenance. Maintaining them also requires a lot of manpower.

Solar powered toilets | Universally accessible | Baby care room | Waster water efficiency | Sanitary pad dispenser

18.5 PROPOSED DESIGN OF THE YOGA AND MEDITATION PAVILION



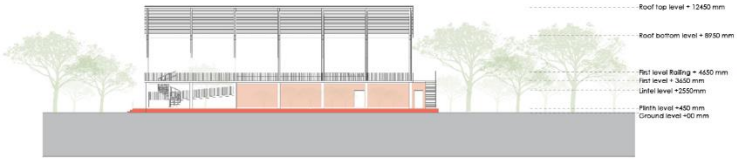
View of the Meditation pavilion

METAMORPHOSIS – Ecological Restoration and Development of an abandoned quarry, a case of ARAI Stone Quarry, Pune

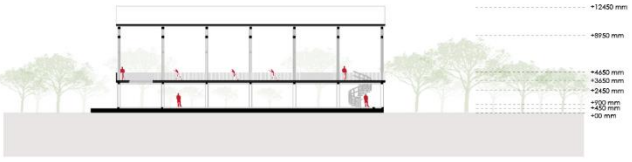
Interior View of the meditation pavilion

View of the meditation pavilion showing the contemplative pool

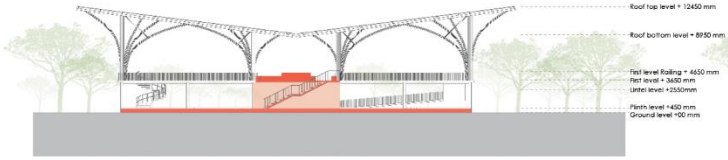
View of the meditation pavilion showing the access ramp



East Elevation



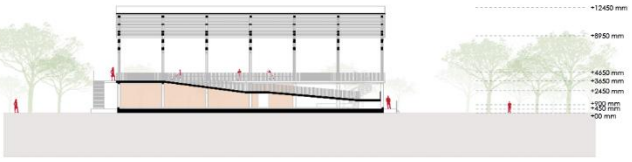
Section A-A'



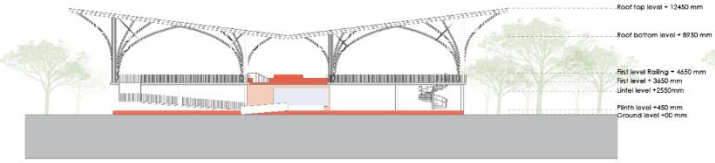
South Elevation

Section B-B'

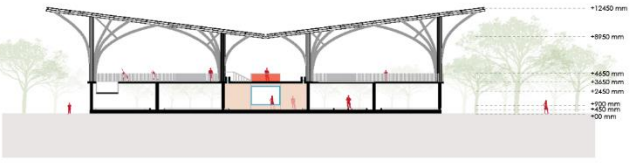
West Elevation



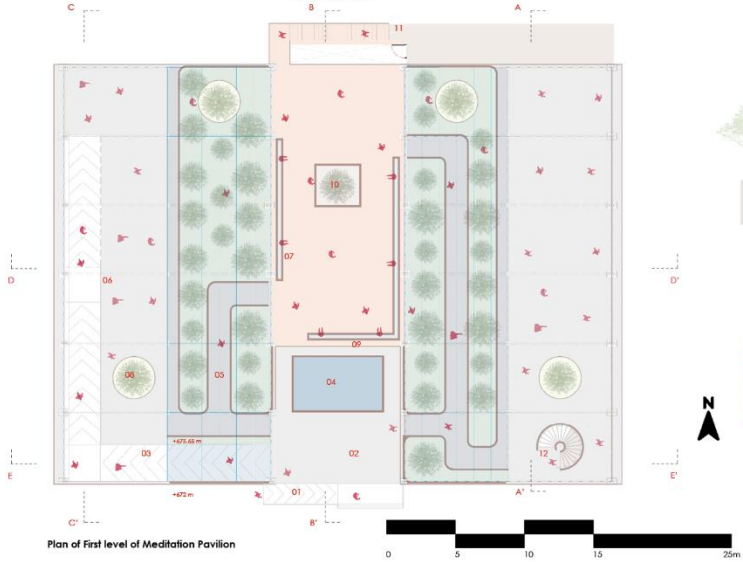
Section C-C'



North Elevation



Section D-D'



Plan of First level of Meditation Pavilion

Section E-E'

Legend

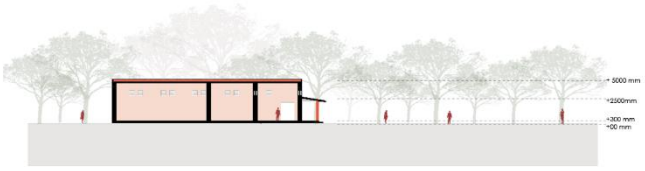
01 Up ramp (gradient 1:12)
02 Entrance to the meditation pavilion
03 Up ramp (gradient 1:12)
04 Contemplation pool
05 Glass floor
06 Slab floor
07 Skylights of contemplation gallery used as seatings
08 Punctures in the floor for trees
09 Railings made out of bamboo
10 Gravel courtyard
11 Service staircase
12 Spiral staircase
13 Bamboo mounted on a steel base plate

18.6 PROPOSED ADAPTIVE REUSE OF THE ABANDONED OFFICE INTO AN EXHIBITION GALLERY

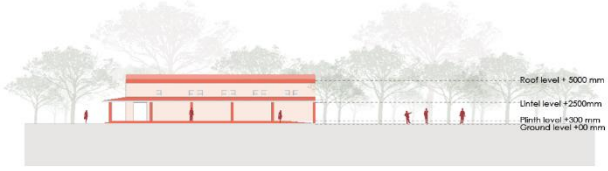
View of the abandoned structure and open exhibition space

View of the abandoned structure and open exhibition space

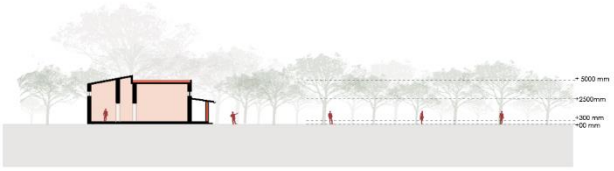
View of the abandoned structure and open exhibition space and fire seatings



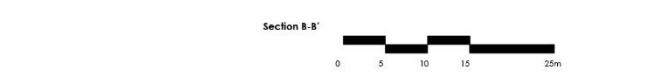
Section A-A'

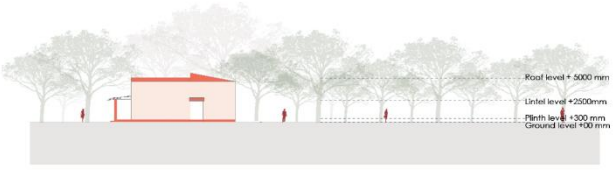


South Elevation

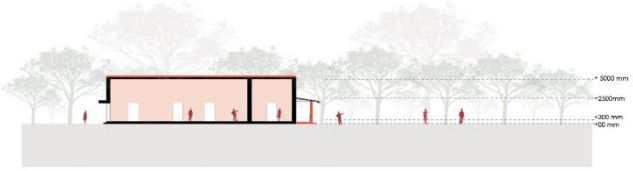


Section B-B'

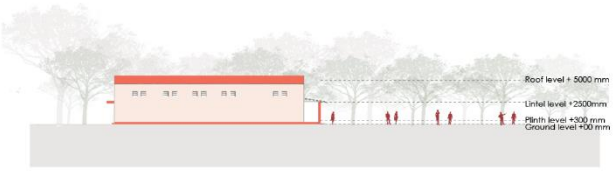




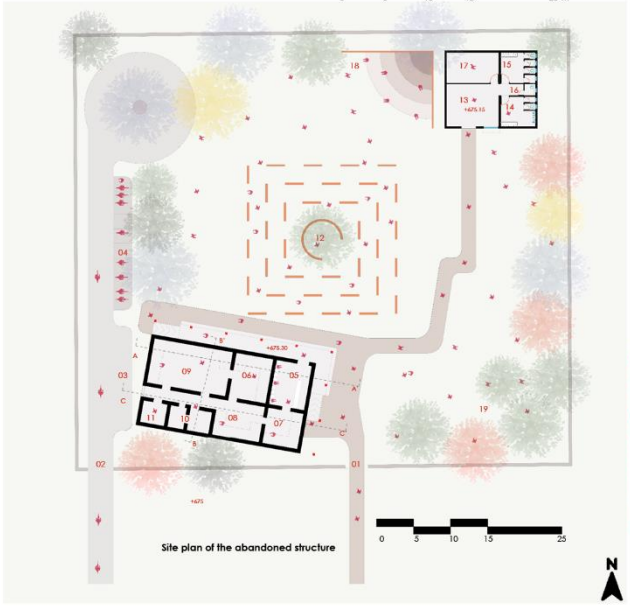
East Elevation



Section C-C'



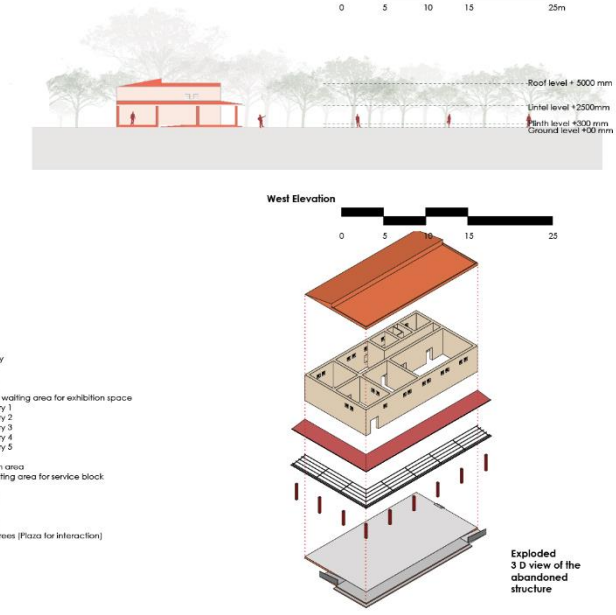
North Elevation



Site plan of the abandoned structure

Legend

01 Pedestrian entry
02 Vehicular entry
03 Drop off bay
04 Cycle parking
05 Reception and waiting area for exhibition space
06 Exhibition gallery 1
07 Exhibition gallery 2
08 Exhibition gallery 3
09 Exhibition gallery 4
10 Exhibition gallery 5
11 Store room
12 Open exhibition area
13 Admin and waiting area for service block
14 Men's toilet
15 Women's toilet
16 PWD toilet
17 Store room
18 Amphitheater
19 Swings on the trees (Plaza for interaction)



West Elevation

Exploded 3 D view of the abandoned structure

19.0 FINANCIAL ASPECTS OF THE PROJECT

19.1 BLOCK ESTIMATE

ESTIMATE @ Rs. 15,000 per sqm			
NOS.	**DESCRIPTION**	**AREA**	**ESTIMATE (Rs)**
1	**Information centre**	**452**	**Rs 65,20,000**
2	**Nature interpretation centre**	**2200**	**4,40,00,000**
3	**Yoga and meditation Pavilion**	**2430**	**1,56,00,000**
4	**Toilets/ locker room**	**500**	**50,50,000**
5	**Bird watching points**	**5 x 200**	**40,00,000**
Supporting infrastructure like electricity, road, pisciculture, water, small constructions, compound, lighting.			**5,00,00,000**
	Total Estimate		**13,71,70,000**

Fig 23 – Block estimate

19.2 OPERATION AND MAINTENANCE COST

Manpower is considered to be Rs 365000.00 per month

1	Manager @ 65000 per month	Rs 65000
2	10 Helpers @ 18000 per month	Rs 180000
3	1 Accountant @ 30000 per month	Rs 30000
4	5 Security persons @ 18000 per month	Rs 90000

Consumables Rs 100000.00 per month

(Stationery, printing , banners)

Electricity / Water Rs 45000.00 per month

Operation and maintenance Cost Rs 5.10 Lacs per month

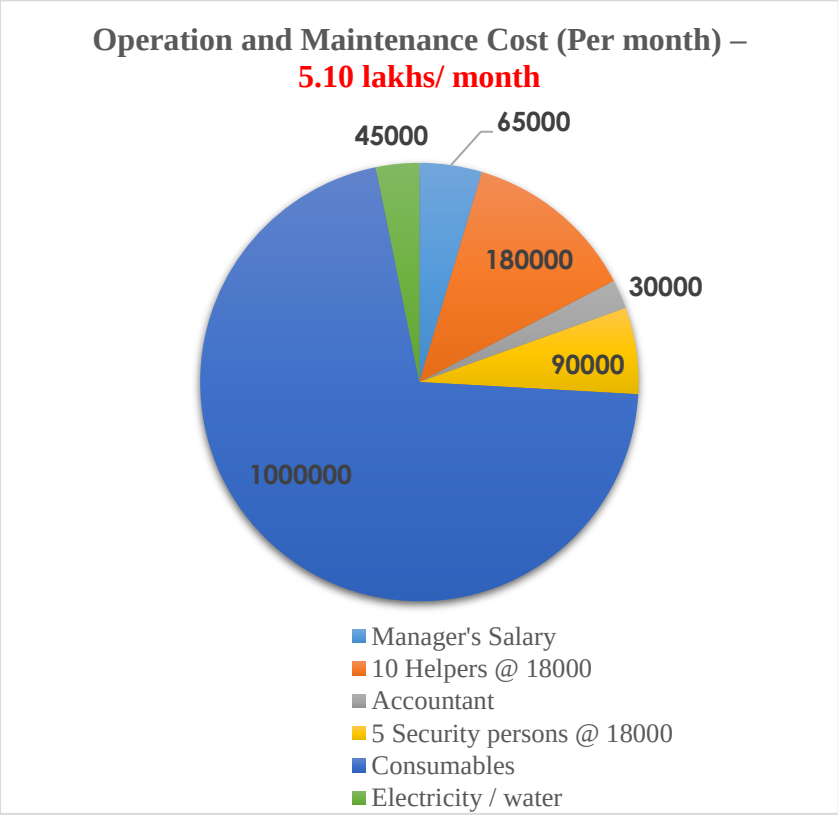


Fig 24 – Operation and maintenance Cost

19.3 RETURN PERIOD CALCULATION

Capital Expenses: **Rs. 14.0 Cr**

Maintenance: **Rs 7.0 Cr for 10 years**

Expected Government Grant: **Rs. 10.00 Cr**

Expenses over 10 Years

(Including capital cost – grant) **= Rs. 11.00 Cr**

Per year Revenue**: 1.72 Cr**

Return period = 7 years

Assumption:

1. Operation and maintenance cost is increasing at the rate of inflation
2. Entry fees shall be revised in proportion with rate of inflation
3. Revenue from plantation shall be extra

20.0 GOVERNMENT FUNDINGS

Compensatory Afforestation Fund Management and Planning Authority (CAMPA) funds.

also be used to rejuvenate wetlands, and infrastructure development to support the rejuvenate.

Capital and Revenue Grants of Urban Local Bodies (Entry Fees)

Also, The ULBs can make conditions and provisions to collect entry fee as their revenue to meet O&M costs of the facility created.

21.0 PROJECT PHASES

Phase 1	**Phase 2**	**Phase 3**
1.Selected site contours joined by dredging	1.Soil media formation and wetland edging.	1.Developing Trails, Fencing, information panels.
2.Building afforestation infrastructure	2.Implementing plantation drives (Herbal Park and butterfly park)	2.Introduction of Pisciculture and water lily and water chestnut plantations.

Fig 25 – Phases of ARAI Quarry development

22.0 CONCLUSIONS

The study highlights the experiences of the users – people native to Pune, as far as the Nature trail of ARAI stone quarry is concerned. These experiences and the issues raised regarding safety and security, cleanliness, way – finding, etc. from them will help in formulating related guidelines, policies and best practices for the sustainable redevelopment of abandoned stone quarries across India. The primary data collected from the newspaper articles highlighting cases of rape and theft on the quarry's nature trail will also help in formulating an ideal model of abandoned quarry redevelopment.

Finally, through its outcome, the research intends to establish a set of measures and basic infrastructure that will help in giving the visitors of the quarry a holistic and refreshing experience of the natural landscape that has thrived along the quarry. This model will act as an escape from the chaos of the city and in turn rejuvenate their souls.

22.0 REFERENCES

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CERTIFICATE OF COMPLETION

This is to certify that this thesis project titled "**METAMORPHOSIS – Ecological Restoration and Development of ARAI Stone Quarry, Pune**" was carried out by Smt. **Sanika Upasani**, a student of **Bachelor of Architecture (B. Arch)**, at the **Dr. B. N. College of Architecture**. The research for this project was undertaken under the guidance of the afore-mentioned institute and completed during the period of **01/01/2022** to **25/07/2022**.

This project was shortlisted under the *Sponsored Thesis Project Competition on "RE-IMAGINING URBAN RIVERS" (Season- 2)* hosted by the National Institute of Urban Affairs (NIUA) and the National Mission for Clean Ganga (NMCG).

This report has been submitted by the student as a final deliverable under the competition. All parts of this research can used by any of the undersigning parties.

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Signature	-	

2. Institute

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Department	-	Architecture
Authorized Representative	-	Dr. Kavita Murugkar
Signature	-	

3. Sponsors

Name	- National Institute of Urban Affairs
Authorized Representative	- Hitesh Vaidya, Director
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Name	- National Mission for Clean Ganga
Authorized Representative	- G Asok Kumar, Director General
Signature	-