

METAMORPHOSIS – Investigating the current state and possible ecological restoration of abandoned quarries, a case of VETAL HILLstone quarry, Pune.

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Abstract

Metamorphosis is change of physical form, structure, or substance. Traditionally, after a quarry is exhausted of its material content it is abandoned by the owners and this leaves anthropogenic scars on the land and the ecosystem around it. 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 Vetral hill stone quarry (ARAI) and aims to create this study area as a case study of the adaptive reuse and ecological restoration of an abandoned stone quarry. The research is conducted for understanding the positive and negative experiences of the people who have visited Vetral hill nature trail at least once. The study examines the various challenges faced by the visitors with respect to the facilities and the possible interventions that can enhance their experiences. A quantitative and qualitative research methodology is adopted. A survey method is employed with the help of Google Forms to obtain insights from respondents from Pune city. The experiences, challenges and the opinions shared by the respondents are highlighting the various issues faced at Vetral hill 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 Vetral hill stone quarry and in turn setting an example for the adaptive reuse of abandoned stone quarries.

Key Words - *reclamation, abandoned stone quarries, ecological restoration of stone quarries, wetland bio-diversity, bio-diversity park, adaptive reuse of stone quarries, nature trail.*

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 when not maintained or when the industrial influx in them is not regulated, 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 Vetel hill stone quarry watering hole (ARAI) is studied.

Study area

Background on Vetel hill

Bhamburda Van Vihar includes Vetel Hill (ARAI), which is situated on the western edge of the Pune Municipal Corporation within the municipal limits. Visible from Pashan, Panchavati, Chaturshringi, and other areas of the city, Vetel Hill is a notable hill. Fergusson College Hill and Chaturshringi Hill are two of its spurs. From the south, a single access road climbs the slope. This can be utilized to get to the hilltop campus of the Automotive Research Association of India.

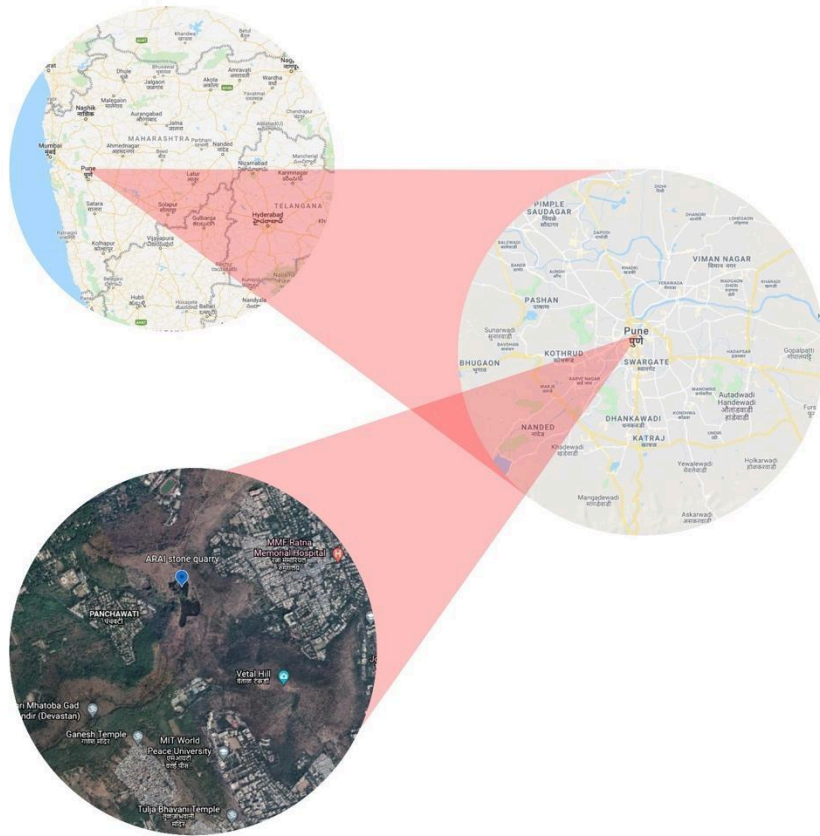


Figure 1 Location map of Vetil hill stone quarry watering hole - Pune, Maharashtra.

Source – Google maps

Table 1 Factfile of Vetil hill, Pune.

Source – Author

FACTFILE – VETAL HILL	
Reservation	Forest
Type of forest	The natural dry vegetation has a dry deciduous nature, without tall trees and with medium sized trees and shrubs.
Site area	5.9 Ha
Depth of the quarry hole	Avg. 12 mts.
Height of Vetil hill	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%
Climate of Pune	Composite moderate climate which is hot dry and wet dry
Rock type	Basalt, a common extrusive volcanic rock



2003



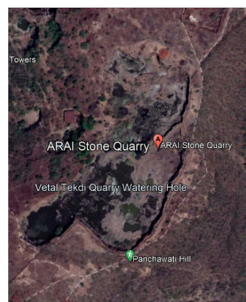
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2008



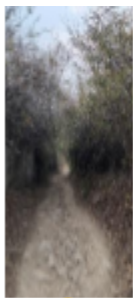
2013



2020



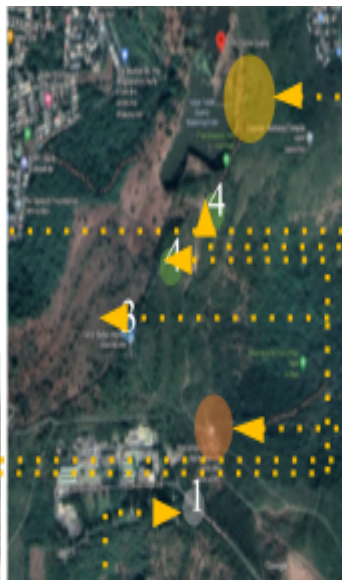
2021



Nature trail



Vetai Baba mandir



Google image
of Vetai hill
quarry nature
trail

Parking



Vetai Hill quarry watering
hole



Hanuman temple

User group and observed activities

There are many walkers, joggers, cyclists, and trekkers on the Vetel hill region's undulating hill paths. Young lads engage in ball games under huge trees.

The platform close to the Hanuman Shrine and the surrounding area through the long grass and rocks is used by people of different ages for a variety of activities including but not limited to resting, catching up with friends, picnics, etc.

For their annual movement between the western regions of Maharashtra and the Konkan, Dhangars and other nomadic or semi-nomadic pastoral clans make a stop at Vetel hill at specific periods of the year. The hill's original vegetation included grassland and only a few isolated pockets of woods, which was suitable for grazing animals even if it currently boasts plantations of social forestry. The cattle feed on the lush grass and other vegetation.

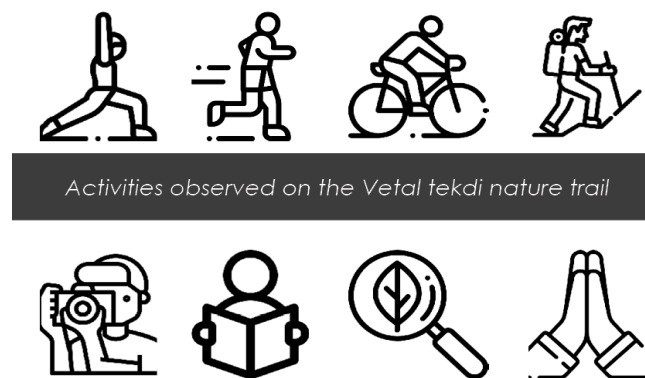


Figure 4 Activities observed on Vetel Hill nature trail and quarry watering hole

Source – <https://www.vecteezy.com/>

Hydrology analysis of the Vetel hill stone quarry watering hole

Table 2 Hydrology Analysis of Vetel hill stone quarry watering hole

Source - Author

HYDROLOGY ANALYSIS – VETAL HILL 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

Research done in the past state examples of case studies of the quarries that are located outside India. Little research regarding the study of the ecological restoration of abandoned quarries has taken place in the Indian context. So, a case of Vetil hill stone quarry watering hole, a stone quarry located in the city of Pune, India is taken up for this research study.

1. To document the opinions about the visitors' past experiences and satisfaction levels of visiting the nature trail.
2. To identify the exact nature of barriers, threats and obstacles experienced by the users of the trail.
3. To identify and propose the interventions that would enhance the experience of visitors of the Vetal hill nature trail and to create a framework for the adaptive re-use of the quarry watering hole.
4. To analyze the cost-benefit model for the proposed project.

Literature Review

Review of News Articles

15/02/2021

15-year-old student raped on hillock in Pune: Times of India

1

Printed from
THE TIMES OF INDIA

19-year-old student raped on hillock in Pune

THE TIMES OF INDIA



po.ica (zone II) Rishavji Tal.

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

Speaking to TOI, inspector Sawant said the woman stays in 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 6:30 pm and started reading her book. "Around 6:45 pm, an unidentified man grabbed her from behind and gagged her so that she could not raise an alarm. He kept repeating 'pausa pause' (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 no sound was coming from her, he picked up her purse, cell phone and a bag, 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.

!9 year old student **raped** on hillock in Pune

Source – The 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 6:45 pm.

PUNE NEWS

Teenager falls into quarry off Vetel Tekdi, fractures leg

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

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



A 16-year-old boy who had gone to visit Vetel Tekdi with his friends slipped and fell off the edge 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 spot and rescued the teenager from the water body at the bottom of the stone quarry, located beside Vetel Tekdi. A blood running down his face. Sanjay Bhavkar, an official of Erandwane fire brigade division who is posted at the tower located atop Vetel Tekdi was the first one to respond.

Teenager **falls** into quarry off Vetel Tekdi, **fractures leg**.

Source – Hindustan Times

A news article dated Jan 2021 reports a case of a 16-year-old teenager who fell down into the quarry off Vetel tekdi and sustained injuries on his back and head. The Fire Brigade official has stated that two – three cases such cases every year.

15/02/2021

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

3

Printed from
THE TIMES OF INDIA

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

THE TIMES OF INDIA



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 Vetel Tekdi, was threatened by a man with a broken liquor bottle and robbed of Rs 7,000 around 11:30 am on Saturday. The victim later lodged a complaint with the Chaturbhungi police.

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

Pune: Techie strolling with kin on Vetel Tekdi **robbed**.

Source – The times of India

A news article from the Times of India dated Dec 2020 reports a case of robbery of Rs. 7,000 that happened at around 11:30 am 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).

4

FOR YOUR SAFETY, GO IN GROUPS

File photo

- Do not go alone for any activity on the hillocks during odd hours
- Always go in a group
- Do not carry valuables with you while going to such places
- In case of an emergency, contact the police control room
- Control Room Number | 100
- Police patrol the area, urging people to stay away from the hills after 7 pm
- In past too, walkers have been robbed, some have been attacked and women have been harassed by lumpen elements



For your SAFETY, **GO IN GROUPS**.

Source – The times of India

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

Figure 6 News Articles highlighting accidents on Vetel hill stone quarry nature trail

Review of past researches

The research conducted in the past has been written by considering various case studies of the existing quarries and their current conditions. These case studies are from various parts of the world and the way people perceive these as natural landscapes has been 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. (Sapfo Tsolaki-Fiaka, 2018)

A study discusses 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 the matrix of schemes?’ (Katia Talento, 2020). The paper also discusses a brief history of the notion of quarry reuse and the new value of industrial landscape.

Another research encourages the rehabilitation of land disturbed by quarrying by making the areas suitable for new sustainable land uses. The authors have 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 (McCandless, 2013). The five cases are each located in a different geographic locations—none in the Indian context and vary in the time in which the projects were undertaken. A study done in 2017, presents high attractiveness of shape form in abandoned quarry areas, as well as for indicating social interest in the areas in terms of their attractiveness. (Kaźmierczak2, 2017)

In a study, ‘Study on sustainable landscape design of abandoned quarries - An example: Zhushan ecological park in Xuzhou’, the authors 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)

A Multi-Criteria Decision Analysis for an Abandoned - Quarry in the Evros Region (NE Greece) identifies 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 conclusion of the study reflects 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)

Conclusion from the literature review

Research studies done in the past suggest 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 affair 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.

Research Methodology

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 Vetal hill stone quarry.

The respondents in this study included respondents most of who are primarily from Pune, mainly from urban areas, and are regular visitors at Vetal hill stone quarry's nature trail. The sample of respondents represents a diverse population of people who have visited Vetal hill at least once with respect to the personal characteristics such as age, gender, profession, frequency of visits, challenges faced at Vetal hill, positive and negative experiences of the same. Secondary data collection was done by looking up news articles from the past which throw light on the issues and threats experienced in the Vetal hill 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 Vetal hill stone quarry at least once. The Google survey form was circulated on April 7, 2021.

Questionnaire

The key questions posed were –

*Set A – For obtaining 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 Vetat hill?*
- *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 Vetat hill in the past?*
- *What challenges do you face at ARAI?*
- *What is Vetat hill for you?*

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

- *Rate according to your past experiences at Vetat hill –*
1. *Safety and security*
 2. *Vandalism*
 3. *Ambience*
 4. *Cleanliness*
 5. *Ease of way – finding.*

*Set E – For studying **possible interventions at Vetat hill.***

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

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 Vetat hill. 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 the respondents from Pune city. The experiences, challenges and the opinions shared by the respondents highlight the various issues faced at Vetat hill. The findings of the study can be applied to develop the nature trail along Vetat hill stone quarry.

What is ARAI (Vetal Tekdi) for you?

69 responses

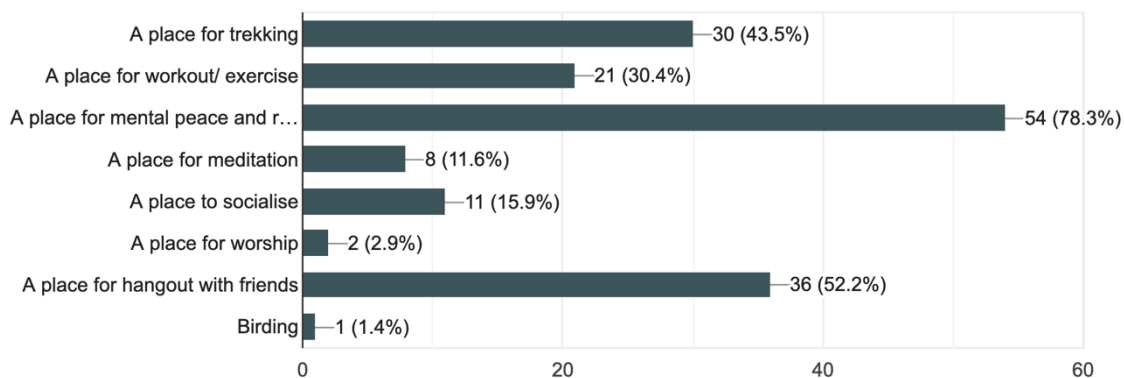


Figure 7 Graph highlighting the significance of Vetal hill to the visitors

Source – Survey conducted by the author

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

Positive experiences of the respondents at Vetal hill, 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 rejuvenating.
- Excellent scenic views.
- Respondents have emotional sentiments attached to this trail.

Negative experiences of the respondents at Vetal hill, 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.

Challenges faced by the respondents at Vetal hill, Pune

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 because of lack of signages
- Cases of theft.
- Lack of washrooms and basic amenities.

Spaces that the respondents want along the trail in Vetel hill, Pune

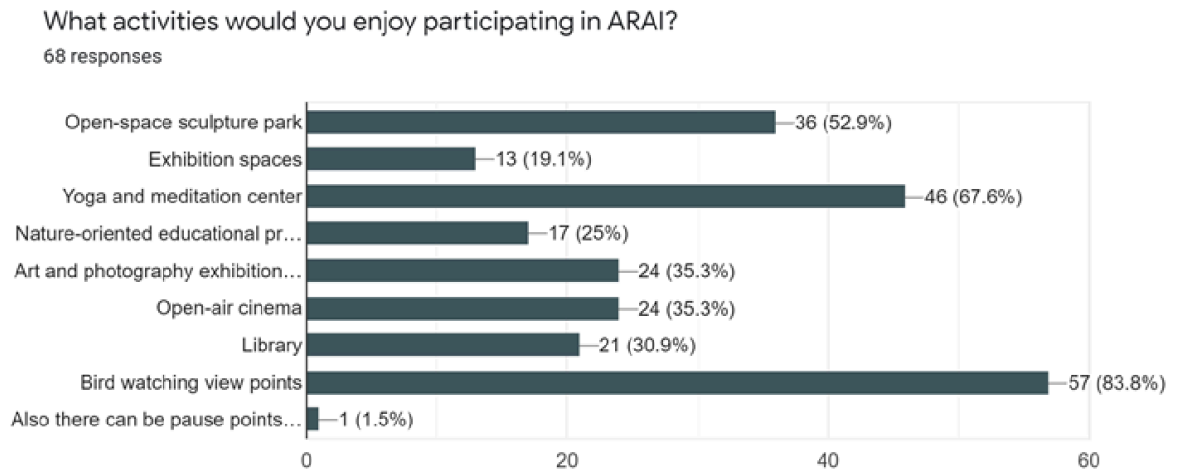


Figure 8 Graph highlighting the activities that visitors would prefer on Vetel hill

Source – Survey conducted by the author

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.

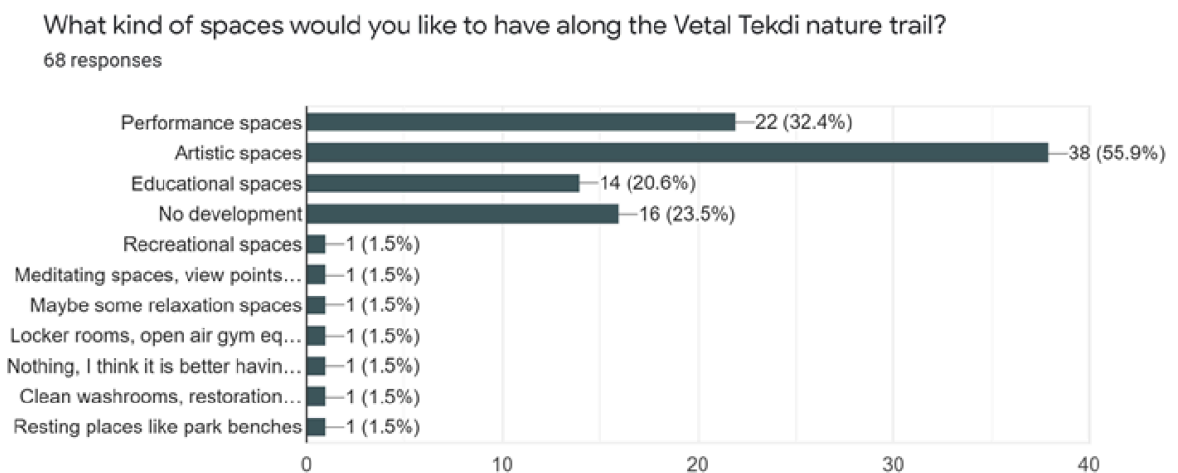


Figure 9 Graph highlighting the spaces that visitors would enjoy on their visits to Vetel hill

Source – Survey conducted by the author

Survey on the kind of spaces that the respondents would like to have in Vetel hill 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 occasionally 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.

Discussion

This investigation related to the experience of people who have visited the Vetel hill 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 and ecologically restored. This survey is based on positive as well as negative experiences, challenges faced by them and the possible 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 Vetel hill quarry watering hole 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 Vetel hill 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 Vetel hill 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 notorious.

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 Kalewadi 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 led to issues of safety in the minds of the visitors.

The findings from this survey have brought out the dire need to intervene in Vetel hill 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 Vetel hill), first aid facility on hill, 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 Vetel hill and plantation of native trees. These interventions will enhance their experience of the nature trail while also making it safer.

OBSERVATIONS AS PER THE SITE VISIT TO ARAI NATURE TRAIL CONDUCTED ON 25/02/2021, 6:15 PM – 7:30 PM



Proposal for the Ecological restoration of Vetat hill stone quarry watering hole

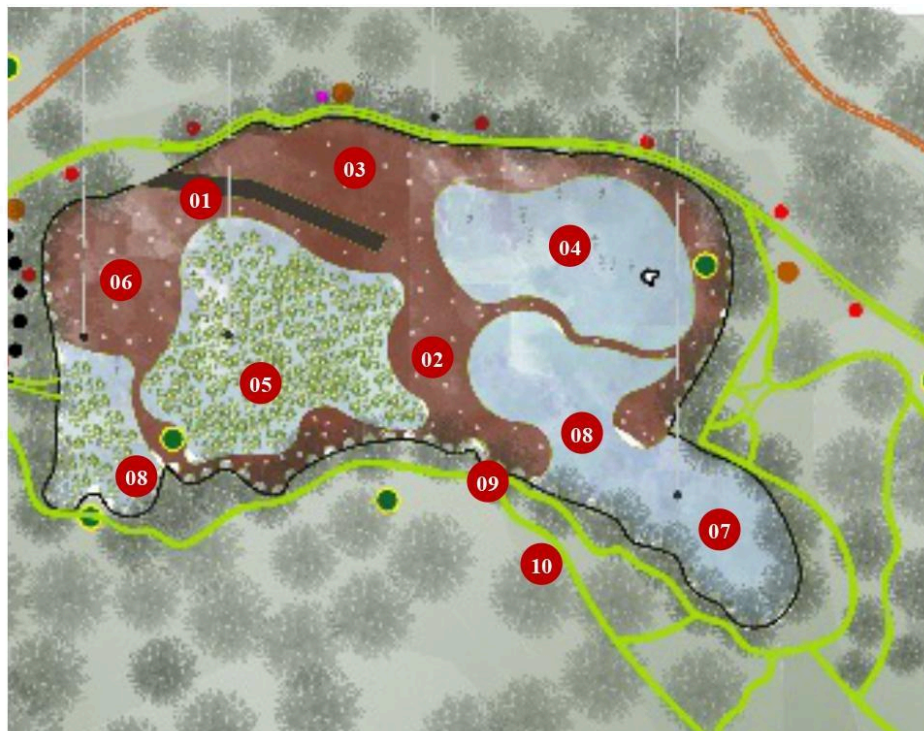


Figure 11 Proposal for the Ecological restoration of Vetat hill stone quarry watering hole

Source – Author

Table 3 Legend for the proposed ecological restoration of Vetat hill stone quarry

01	01 Entry ramp leading to the quarry	06	Open air sculpture park and butterfly garden
02	Information pavilion	07	Pisciculture
03	Herbal garden	08	Decks for fishing
04	Rock climbing activities	09	1.2 mt wall to avoid water to drain away

05 Water lily and water chestnut plantations 10 Thorny plantation on edge

Design Proposal

Small wall (1-2mts height) to create wetland like conditions to not let the water drain away from the quarry. Introduction of silt from other places (Pashan Lake) from where hydrophytes – algae, micro fauna and flora will flourish in such conditions resulting in increase in the ecological value.

Plantation of thorny shrubs around the periphery of the quarry to avoid accidents. The stakeholders need to assure protection and make sure that the water should stay there.

In case of Vetil hill stone quarry watering hole, fortunately, there's no introduction of sewage influx. Introduction of pisciculture will improve the ecological value of the water and quality of water will remain good. Pisciculture is introduced it in a smaller catchment area.



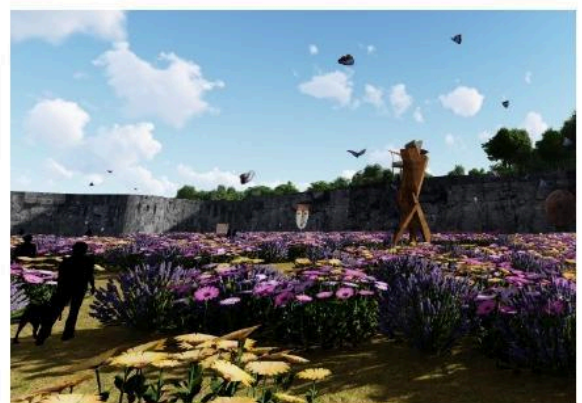
01 - Entry ramp leading to the quarry



02 - Information pavilion and water lily and lotus plantations



06 - Decks for fishing (Pisciculture)



03 - Open air sculpture park and butterfly garden

Figure 12 Proposed views of the ecological restoration of the quarry watering hole

Source – Author

Proposed plan for biodiversity park – VETAL HILL nature trail

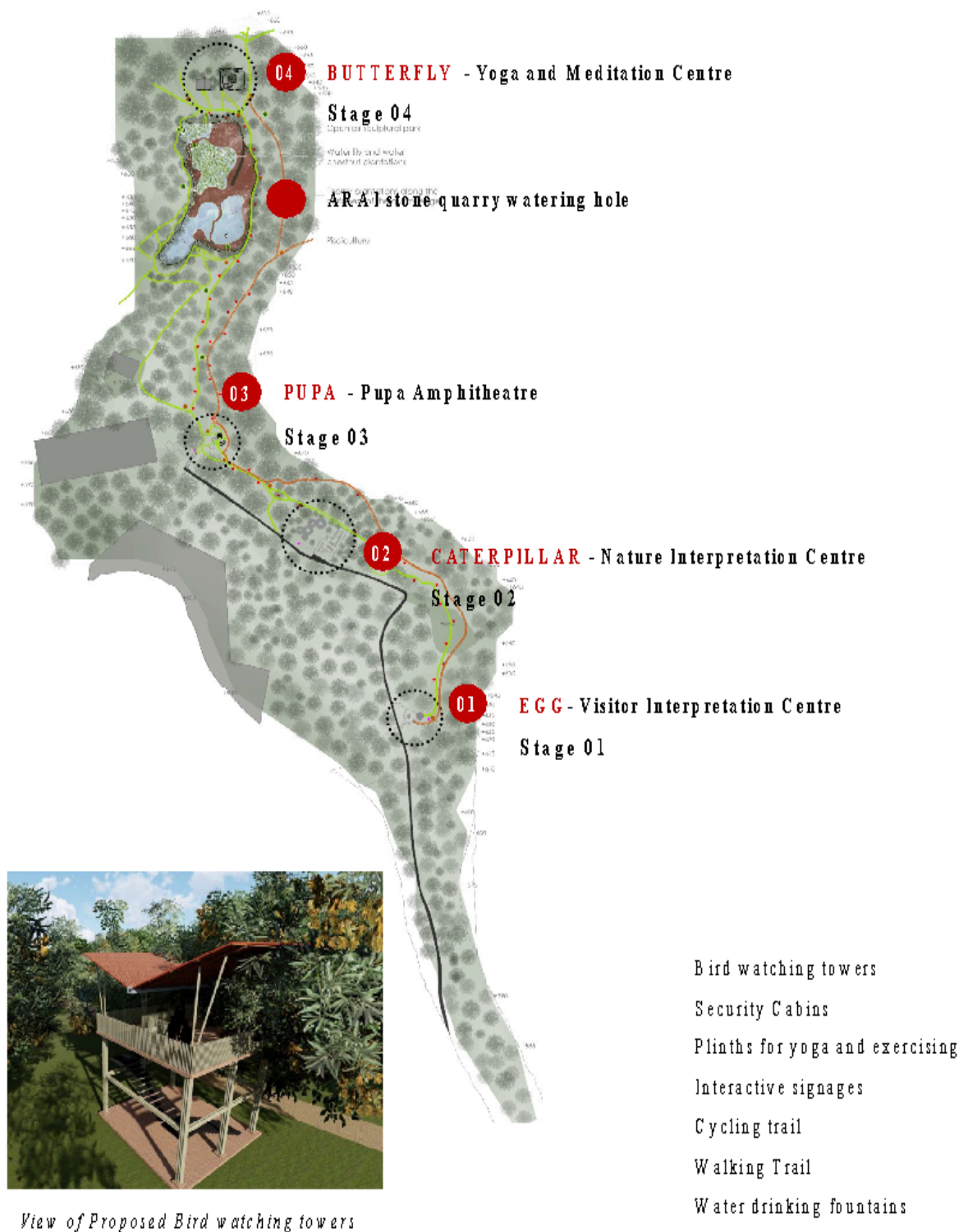
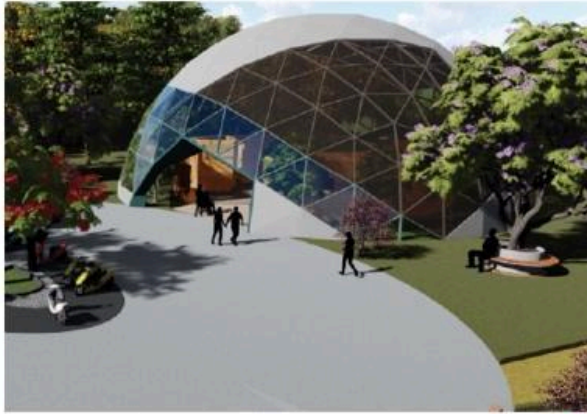


Figure 13 Proposed plan for biodiversity park – Vetal hill nature trail

Source – Author



EGG- Visitor Interpretation Centre

01



CATERPILLAR - Nature Interpretation Centre

02



PUPA - Pupa Amphitheatre

03



BUTTERFLY - Yoga and Meditation Centre

04

Figure 14 Views of the proposed interventions

Source - Author

Implementation Plan

Proposed phases of Ecological Restoration of Vetral hill stone quarry watering hole

Phases of the Project Ecological restoration of Vetral hill stone quarry watering hole and proposed nature trail

Phase 1

Duration - 24 months

Development of proposed built interventions, cycling track, herbal park, pisciculture and water lily and water chestnut plantations.

Phase 2

Duration - 12 months

Development of other built activities like adaptive reuse of the abandoned office, Installation of Information panels, etc.

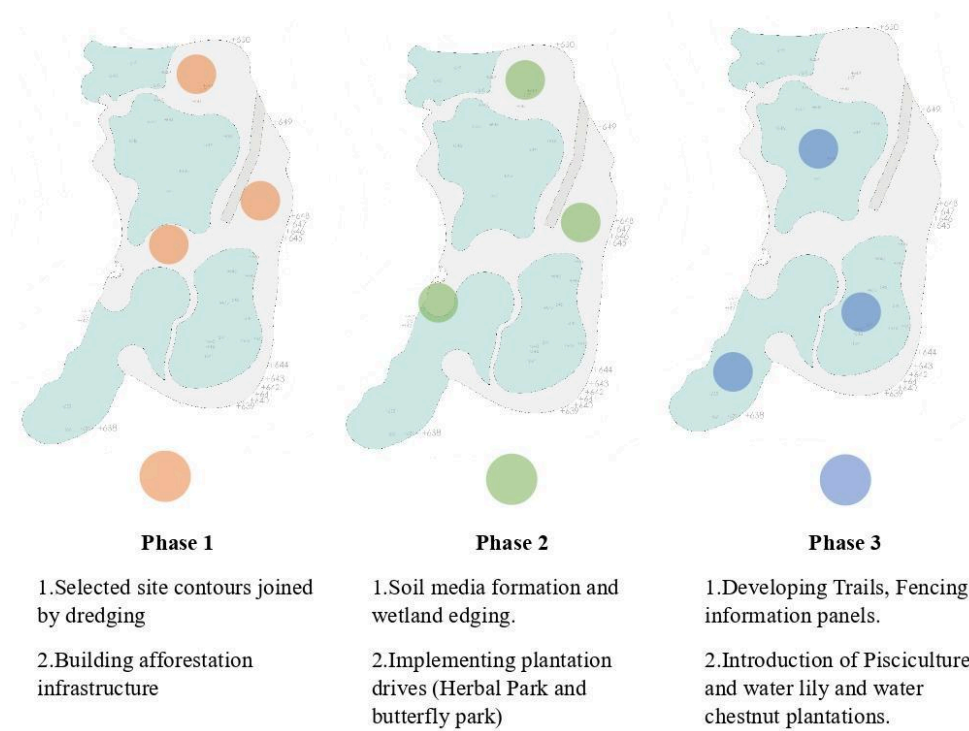


Figure 15 Proposed phases of Ecological Restoration of Vetal hill stone quarry watering hole

Source – Author

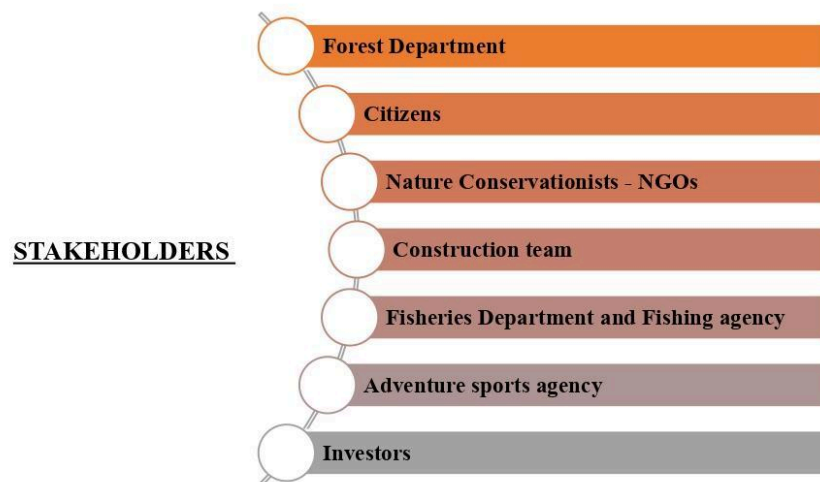


Figure 16 Stakeholders involved in the ecological restoration of the quarry

Source – Author

Proposed Cost model

Block Estimate

Table 4 Block Estimate

Source – Author

Sr. No.	Description	Nos.	B/up area (sq m)	Estimate (Rs.)
01	Information Centre	01	452	65,20,000
02	Nature Interpretation Center	01	2200	4,40,00,000
03	Yoga and Meditation Pavilion	01	2430	1,56,00,000
04	Toilets and Locker rooms	01	500	50,50,000
05	Bird Watching points	5	200	40,00,000
06	Supporting infrastructure like electricity, road, pisciculture, water, menial construction works, compound, lighting.		L.S.	5,00,00,000
TOTAL				13,71,70,000

Operations and Maintenance Cost

Table 5 Operations and Maintenance Cost

Source – Author

Sr. No.	Designation	No. of personnel's	Salary/ head/ month (Rs.)	Estimate/ month (Rs.)
01	Manager	01	65,000	65,000
02	Helpers	10	18,000	1,80,000
03	Accountant	01	30,000	30,000
04	Security persons	05	18,000	90,000
	Total for Manpower			3,65,000
05	Consumables (Stationery, printing, banners)	L.S.		1,00,000
06	Electricity/ water Consumption	L.S.		45,000
TOTAL OPERATIONS AND MAINTENANCE COST				5,10,000

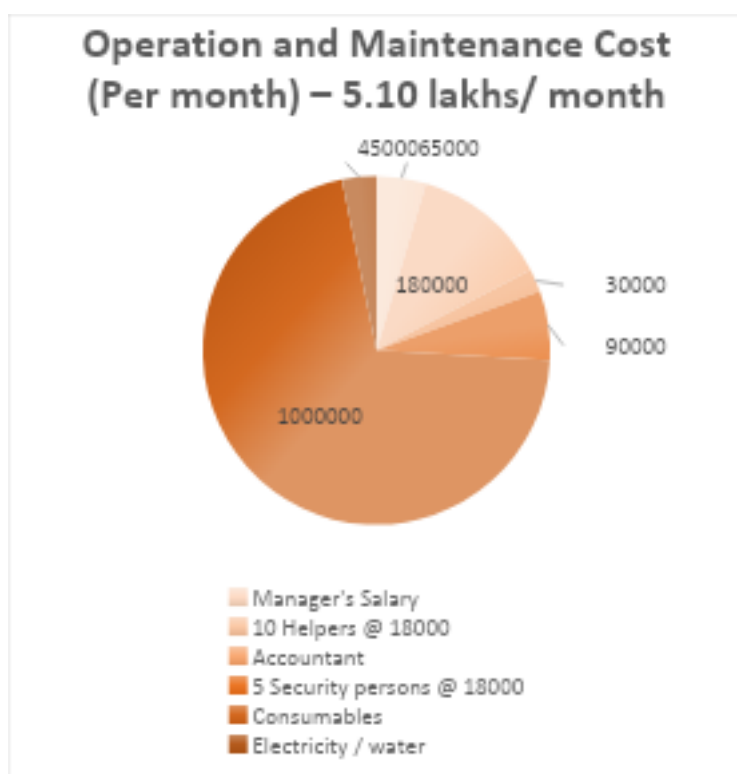


Figure 17 Operations and Maintenance Cost

Source – Author

Expected annual revenue

Table 6 Expected annual revenue

Source – Author

Sr. No.	Description	Qty.	Rates	Amount
01	Annual Morning Walkers (per day 500)	1,80,000	Rs. 5.00 per day	9,00,000
02	Annual evening Walkers (per day 300)	1,08,000	Rs. 10.00 per day	10,80,000
03	Park Entry (1500 per day)	5,40,000	Rs. 25.00 per day	1,35,00,000
04	Annual Advertisement	5	Rs. 1,00,000 per hoarding	5,00,000
	Art Gallery Rent	20	Rs. 25,000 per event	5,00,000
	Parking revenue	36,000	Rs. 20.00 per vehicle	7,20,000
	TOTAL ANNUAL REVENUE			1,72,00,000

Return Period Calculation

Table 7 Return Period Calculation

Source – Author

Capital Expenses	Rs. 14.00 Cr.
Maintenance	Rs. 7.00 Cr. (for 10 years)
Expected Government Grant	Rs. 10.00 Cr.
Expenses over 10 years	Rs. 14.00 Cr. + Rs. 7.00 Cr. = Rs. 21.00 Cr.
Capital Cost – Grant	Rs. 21.00 Cr. – Rs. 10.00 Cr. = Rs. 11 Cr.
Per year Revenue	Rs. 1.72 Cr.
Return period	Rs. 11.00 Cr./ Rs. 1.72 Cr. = 7 years

Assumptions –

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

Possible Government fundings

1. **Compensatory Afforestation Fund Management and Planning Authority (CAMPA) funds.** also be used to rejuvenate wetlands, and infrastructure development to support the rejuvenate.
2. **Capital and Revenue Grants of Urban Local Bodies (Entry Fees)**
3. Also, The ULBs can make conditions and provisions to collect entry fee as their revenue to meet O&M costs of the facility created.

Conclusion

The study highlights the experiences of the users – people native to Pune, as far as the Nature trail of Vetal hill 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 ecologically restored 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 the souls of the visitors.

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Conflict of interest

Authors has no conflict of interest to declare.

Bibliography

- Sapfo Tsolaki-Fiaka, G. D. (2018). Multi-Criteria Decision Analysis for an Abandoned. *Land* 2018, 16.
- Katia Talento, m. A. (2020). *Quarries: From Abandoned to Renewed Places*. Lisbon.
- McCandless, C. (2013). *No longer just a hole in the ground*. MIT.
- Kaźmierczak2, E. B. (2017). The Landscape Attractiveness of Abandoned Quarries. *Geoheritage* , 14.
- Zhu Dong-dong, S. Y.-s. (2009). Study on sustainable landscape design of abandoned quarries. *International Conference on Mining Science & Technology*, (p. 8). Xuzhou, China.