

**GEO-PARK DEVELOPMENT PLAN FOR KHARI RIVER GORGE LANDSCAPE
BHUUJ, KUTCH, GUJARAT**

Submitted
*In partial fulfillment of the requirements for the
award of the degree of*

**MASTER OF ARCHITECTURE
(LANDSCAPE)**

By

Janki Gonawala
Sch. No.2016mlao15



**SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL
NEELBAD ROAD , BHOURI, BHOPAL – 462030**

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DECLARATION

Department of Landscape
School of Planning and Architecture, Bhopal



DECLARATION

I Janki Gonawala, Scholar Number 2016mla015 Hereby declare that the thesis entitled *GEO-PARK DEVELOPMENT PLAN FOR KHARI RIVER GORGE LANDSCAPE BHUJ, KUTCH, GUJARAT* submitted by me in partial fulfilment for the award of Master of Architecture (Landscape), in School of Planning and Architecture Bhopal, India, is a record of bonafide work carried out by me. The matter embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

21-05-2018

Janki Gonawala

Certificate

This is to certify that the declaration of Janki Gonawala is true to the best of our knowledge and that the student has worked under the guidance of the following panel.

RECOMMENDED

Asso. Prof. Saurabh Popli

ACCEPTED

Prof. Sanjeev Singh
Head, Department of Landscape

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ABSTRACT

Gorge is the narrow valley between the high rocky walls. River or stream is found in the base of gorge. It is an erosional landform which is found in the mountains and hilly regions in different part of the world creating interesting landform, which attracts people to gorge for its high view value, recreation value, educational value and Spiritual Value.

Gorge formation found in the plains of Kutch has altogether different experience. Kutch is a hyper arid region of the Gujarat state. One of the micro watersheds of Khari River exhibits geomorphological condition of bed rock gorge in the main land of Kutch. Landscape of Khari River is a part of the endorheic basin. Generally, Bed rock channels and Gorge are found in upper reaches of the River, from where it decants. However, here Bed rock channel and gorge are observed in rocky plains of Kutch in Bhuj city. It shows many high intensity erosional features on the cretaceous sandstone such as – Gully erosion, Pools, Cliffs, Knick points, Pot holes, Flutes, Terraces and many more features for which its potential to become a Geo-park is put forward by the Gujarat mineral Research & Development society. As this gorge is developed in plains it is more accessible and visible by locals and visitors. Accessibility has created diverse association to the landform which one can observe in contextual and cultural setting around the gorge. This landscape of Khari River is facing many ecological and environmental degradation issues, because of accessibility, uncontrolled visitation, and lack of awareness, ignorance and exploitation of natural resources. In this thesis, Khari River gorge landform is taken as subject and tried to raise questions regarding possibility of management of the defined noteworthy features and wilderness quality of the Khari River gorge landscape through designing a geo park. It is important to develop strategies which can device and regulate the visitation, while maintaining environmental and visual quality of the gorge landscape. A design intervention is required to reveal and built recognition for the site's natural process for visitors, to appreciate and engage with landscape. The Aim is to design Geo Park to focus the observation and experience of natural and cultural process at Khari River.

CHAPTER 1: INTRODUCTION

Research questions

1. How to manage the unique landform features of Khari River Gorge and wild native thorny vegetation of the landscape?
2. What kind of strategy can be device to regulate the visitation, while maintaining environmental and visual quality of the Khari River gorge landscape?
3. What kind of intervention should be provided in geo park, for users and visitors to appreciate site natural landscape and engage them into different educational and recreational activity?

Built environments overlook possibility of people's requisite for learning and acknowledging the natural systems. This attitude of ignorance towards natural system has evident the negative impact on human development. Making natural system profound and bring them in to light through landscape designing. Through Responsive Design one can connect people with nature by informing them about nature and their place in it.

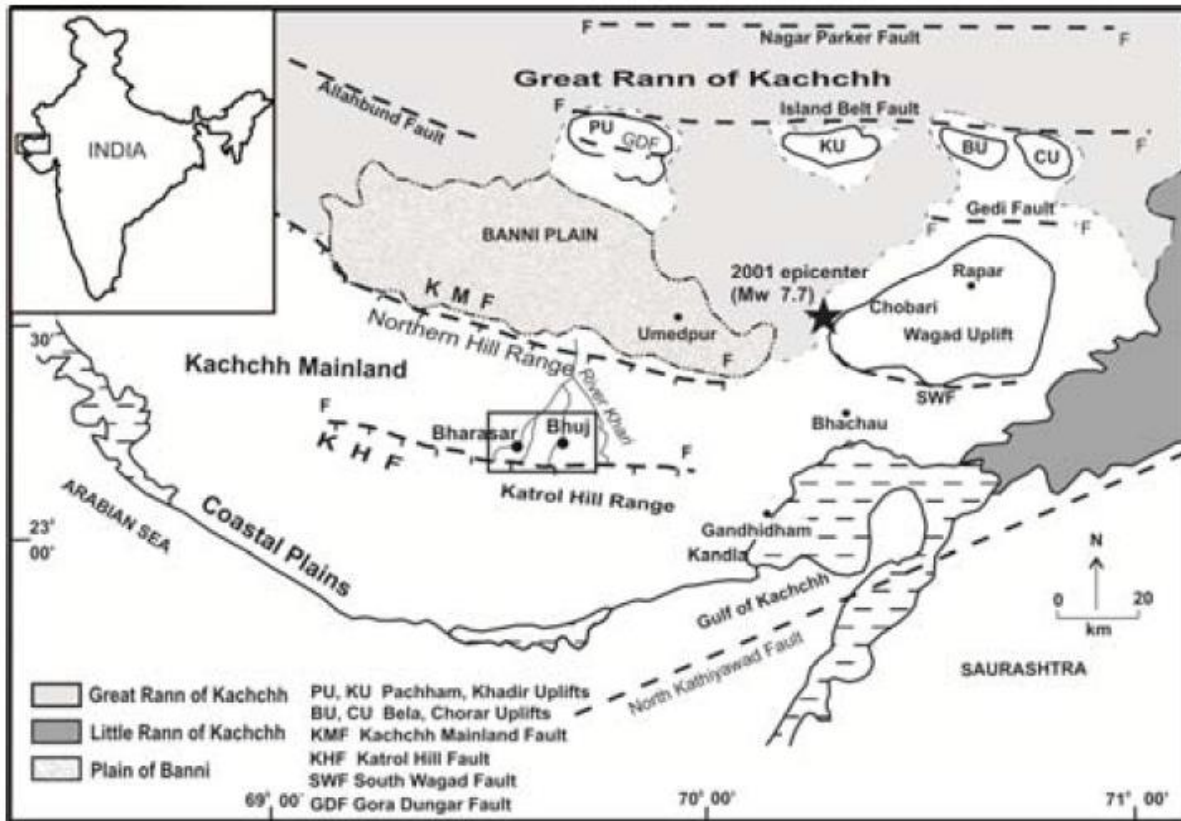
“if one is more aware of environmental phenomena and processes—if one is able to see and comprehend them—one is better able to appreciate, evaluate, and make wise decisions concerning them” (Brown B. H., 1998)

With this idea in mind I am exploring the idea of creating Geo-park at Khari River gorge, in Bhuj, Kutch. By making developing the gorge park a strategic an envelope will be created to set boundary for landscape management. Development of park will stop the shady activity and other disturbances happening on site. By deriving a balance program for Geo park which will engage visitors with landscape. Strategy of making Geo-park will create possibility of learning as well as enjoying in the most natural environment just at the edge of the Bhuj city. Park will provide the prototype for other possible Geo-park of Kutch region, which is proposed by Gujarat mineral research and development society.

1.1 SITE INTRODUCTION – KHARI RIVER KUTCH, GUJARAT

Khari River is located in mainland of Kutch district of Gujarat stat. In mainland of Kutch the Katrol Hill Range is running East – west and creates two main drainage

directions north flowing and south-flowing drainage. In the north flowing drainage system there are various Rivers which makes 5 endorheic basins.



Map 1 Khari River Location

Source: Himanshu Kumar Kundu

Selected site is a part of Pur River basin in north flowing basin, which is visible in the above image. Khari River descends from the Katrol hill range to the north into the rocky plain of Kutch mainland and merges in the Banni – Rann plains. River is ephemeral in character because of occasional precipitation. Erosion is the predominating fluvial process and the lack of deposition, observed on the site. As a resultant of high fluvial erosional processes, it makes bed rock gorge in the rocky plains of the main land Kutch – which is rare phenomena because of its location is not in hilly area but in plains. Currently River is major source of water for irrigation, lively hood (pasture) in many town and villages towards its journey to Rudramata dam. There are many crematoriums along the River. Gorge faces many anthropogenic pressures on ground due to high accessibility and low visibility.

1.2 Background

The Gujarat mineral research and development society has address possibility of developing the Geo-parks and Geo-monuments in Kutch area.

Kutch is outdoor museum of the natural history. It is the only region of the India

which display continuous record of about 200 million years of the development of earth. “*The Mesozoic and Cenozoic rocks of the region open window to high biodiversity of past life, including vertebrate, non-vertebrate and plants*” (Society, Gujarat Mineral Research Development Society, 2018). Kutch is likewise notable for provincial and worldwide connection in geographical investigations. These layers of Kutch geology compose of biodiversity variety and atmospheres condition of the particular time interims in the geographical past.

Protection of this natural history for study and research is the core criteria for creating geo parks. This park will pull in visitors and experts from various backgrounds. Another goal for creating Geo parks is to involve diverse organizations to serve the reason for saving the natural heritage and making a platform for the trading of data, innovative conservation techniques, building social awareness and recognition for geo heritage.

Other important objective for development of Geo-park in Kutch area;

- As the regulatory and responsible authority Geological Survey of India has only identify 26 sites from all over the India., adding more sites will be benefits for the network in India.
- Some of the destinations in Kutch is recognized by international researcher and scattiest as the only unique geo-marvels of the India which phenomena has accrued anywhere else, these sites required protection from the contextual anthropogenic pressure.
- Because of its geological uniqueness development of Geo-park will attract many national and international tourists.
- There are many chances to list these sites in UNESCO Geo-park initiative.

1.2.1 Need of study

Kutch being overwhelmingly a mineral based industry district of Gujarat contributes essentially to the income of the state. A large number of the destinations that should be secured and protected for its natural importance may fall in the dynamic mining zones of Kutch. By developing the Geo-parks the mineral area going to remain secured in these destinations should be assessed to touch base at justification on the zones to be ensured. Numerous locales may not fall in the mining zones but rather might be a piece of woods lands and after assessing the negative and positive impact of the Geo-park development we can also manage the arid zone forest of

Kutch. Local population and contextual city and towns will be beneficiary of this development. The Future generation would get better insight about of priceless heritage of Geo-park.

Khari river gorge is the part of the listed sites in Kutch which need to Be Protected.

List is prepared Gujarat mineral research and development society:

1. Babia Hills
2. Maniyaragarh
3. Lakhpat-Dedhi Areas
4. KapurasiNadi
5. GuvarNadi
6. BermotiNadi
7. BerwaliNadi
8. BarkhanNadi
9. RamaniaNadi
10. RakhaliNadi
- 11. KhariNadi**



Map 2 Proposed Geopark location

Source: K. Swarna et al

Map is showing all the 11 locations on Google earth imagery.

1.3 Synopsis

1.3.1 Aim

The Aim is to design Geo-park to focus the observation and experience of natural and cultural process aesthetically for users and visitors to celebrate the Gorge landform of Khari River.

1.3.2 Objective

- To conduct comprehensive study of site and its context.
- To explore, understand and document site's natural features and anthropogenic layers for delineating site boundary.
- Mapping association of local people with the different zones of the site.
- To analyze and spatially zone the site to identify area for outdoor recreation, nature appreciation, environmental education: Edge area, Interpretation area, Regulatory area, restricted area.
- Applying Intervention strategy to create landscape master plan for the Geo-park and guidelines for watershed area.

1.3.3 Methodology

Site selection

1. Site selection is based on micro watershed study, which exhibit the gorge formation.
2. Administrative boundary and current land use condition is overlaid with natural watershed boundary to generate the site boundary.
3. Demographic study to understand the demand and trends of visitation for site.

Significant natural feature:

1. Abiotic significance of the site
 - Geology and Geomorphology of site to be studied by mapping, sketching and photographic documentation. Significant features are required to be mapped – fault lines, potholes, fishers, flutes, fluvial morphology of the site.
2. Biotic significance of the site
 - Flora Habitat sectional mapping and photographic documentation.
 - Fauna mapping like - Bees, bats, birds, reptiles etc. are through photographic documentation.

3. Landscape appreciation mapping of the site include landcover mapping includes- farm land and pasture land, barren land, structures, edges.
4. Landover map of total watershed area,
5. Texture map of delineated site area,
6. Understanding of proposed land use and site condition in Development plan.

Site zoning

1. The edge area is defined by the condition mapping and ownership of the area and the overlapping of the natural features of the site.
2. Site zoning for Geo-park activity and various city Level Park and allied activity will be carryout. Area zone will be called as Recreational area of the park – picnic area, orchards, experiential trail, pause points, view frame designing, the parking area, resting are. This zone of the landscape will allow visitors to interpret the site on various levels.
3. Regulatory area, will have limited physical accesses through design intervention which includes more physical activity hiking, Educational trails where regulation is required to ensure the health of the landform and public safety. It also includes landscape spaces which exhibit and narrates the geomorphic history of the Khari River landscape. This zone also included ecological sensitive zone where one can spot various birds, reptiles, insects, and plants species which are threatened and endangered.
4. Conservation area must be prohibited for its unique value like – potholes, caves formation, fossil availability. etc. it must be visually connected through various design intervention, which can frame them.
5. Literature study and case study for the design proposal

1.4 expected outcome

1. A management plan for the selected micro watershed.
 - Soil: Soil condition improvement strategies, soil moisture level improvement strategies.
 - Vegetation: Replantation on the River terraces.
 - Hydrology: Strategies for strengthen the waterbody edges and stream condition.
 - Erosion control strategies for the total watershed area.

- Design for better Edge – road edge conditions, farm edge condition proposal for current and future land use.
- Removal of Invasive species and reforestation of the area.

2. A landscape master plan for the designing of Geo-park.

1.5 scope and limitation

Scope

Strategy for the landscape management will incorporate at the selected micro watershed level.

1. Edges shared between private owners and the park will be detailed out carefully to address question like security, visual connectivity.

Limitation

1. Detail proposal for the Geo-park will be done only for the selected site area based on analysis.
2. The thesis is only focusing on the one part of the geo tourism circuit, it will act like a protocol for the rest station which are required to be developed as Geo-park.

CHAPTER 2: LITERATURE REVIEW

Literature review is attempting to answer the questions to understand the project and programme well enough to come up with strategic comprehensive landscape master plan for Geo-park and landscape management plan for the entire watershed area.

QUESTIONS

- What is Geo-Park?
- Why it is important to explore the potential of developing geo park at Khari River Gorge?
- How to design a Geo-park to accomplish the aim of observation and experience of the natural and cultural processes?
- Case study to understand different designing aspects for Geo-park

2.1 WHAT IS GEO-PARK?

The most fundamental definition for Geo park as accepted by UNESCO is given by Patrick J McKeever and Nickolas Zouras.

*“A **Geo-park** is a unified area that advances the protection and use of geological heritage in a sustainable way, and promotes the economic well-being of the people who live there”* (Zouros, 2005).

UNESCO GLOBAL GEO-PARK

“UNESCO Global Geo-parks are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development” (<http://www.unesco.org>).

Geo Park suffices various issues in its surroundings or context due its salient geological features. Geo Park serves as space for the society and tourists to adore the natural beauty of grassland thereby conveying the importance of conservation of cultural heritage, use of natural resources, creating consciousness among the tourist to protect the natural world. Development of such projects will create individuality to the landscape planning and architecture and to the community. Geo park development will help in the expansion of national economic activity through tourism and by generating employment opportunity to local industrialists and dwellers.

2.1.1 A bottom-up approach

A key to the insurance and progression of geographical landmark is through the viable group investment. UNESCO traces new recommendations to build up the reasonable geo park for travellers, clients and partners.

“A partnership and commitment from communities living and depended on the landscape, long-term public partnership and with political support can raise the reorganization for the site on international level, which is one of the most important criteria for Geo-park” (<http://www.unesco.org>).

2.1.2 Fundamental features

There are four basic features for a site to be considered as a UNESCO global geo-park which are as follows:

1. **Geological heritage of international value**

An area will be considered suitable for global geo park if it possesses geological heritage of international value which is analysed by a group of scientific professionals. Through a series of published research and comparative assessment, an area is noted as a geological site.

2. Management

UNESCO Global Geo-parks are managed by a body having legal existence recognized under national legislation. The body constitutes local and regional actors and authorities. Geo parks require proper management with mutual consent in order to proper social, economic and cultural heritage.

“This plan must be comprehensive, incorporating the governance, development, communication, protection, infrastructure, finances, and partnerships of the UNESCO Global Geo-park” (<http://www.unesco.org>).

3. Visibility

UNESCO promotes sustainable economic development through geo-tourism. To encourage the same, Geo park must have visibility. Tourist should be guided with the relevant knowledge and information on geo-park.

Similarly, a dedicated website, maps, data should be provided that connects one site to another geological area.

4. Networking

UNESCO Geo-park ought to have a corporate character. The GGN established in 2004 is a dynamic system where individuals are resolved to cooperate, trade thoughts of best practice, and participate in like manner tasks to raise the quality models of all items and practices of an UNESCO Global Geo-park.

“By working together across borders, UNESCO Global Geo-parks contribute to increasing understanding among different communities and as such help peace-building processes” (<http://www.unesco.org>).

2.1.3 Focus areas of UNESCO global geo-parks

- **Natural resources:** Since the start of humankind, Natural resources gave by the Earth's solid frame has been the purpose behind our social and financial progression. These advantages fuse minerals, hydrocarbons, remarkable earth segments, geothermal essentialness, air and water, and their reasonable use is

basic for the continued with future flourishing of society. Any segment which can be found on Earth has its origin in geology and land shapes, is non-limitless and its abuse must be managed intelligently. UNESCO Global Geo-parks instruct people about the viable use and necessity for trademark resources, paying little mind to whether they are mined, quarried or furnish from the incorporating condition, while meanwhile propelling gratefulness for nature and the reliability of the landscape.

- **Geological Hazards:** Various UNESCO Global Geo-parks propel cognizance of land dangers, including volcanoes, tremors and tsunamis, and various help design catastrophe control frameworks among neighbourhood gatherings. Through informative activities for the close-by people and visitors, various UNESCO Global Geo-parks give information on the wellspring of land dangers and ways to deal with reduce the danger of geological hazards by spreading awareness. These undertakings produce fundamental utmost and add to building more grounded bunches that have the data and aptitudes to enough respond to potential geological dangers.
- **Climate Change:** UNESCO Global Geo-parks collects and stores records of past climate change and spread awareness on current climate change. They furthermore adopt sustainable practises using renewable energies and promotes best standards of green tourism. Some UNESCO Global Geo-parks strengthen green improvement in the region through local intervention, while others display effect of global climate change and its effect on our environment. Such communal and social activities help in spreading awareness among the local communities and imparting knowledge to mitigate and adapt to potential effects of climate change.
- **Education:** It is a fundamental necessity of all UNESCO Global Geo-parks to educate locals of all the age group about our geological heritage and its connections to natural, cultural and intangible heritages. Hence, UNESCO Global Geo-parks offer informational ventures for schools or offer remarkable activities for kids through "Kids Clubs" or unprecedented "Fossil Fun Days". UNESCO Global Geo-parks similarly offer direction, both formal and easy-going, for adults and retired people while various offer getting ready to adjacent people who can by then, along these lines, teach others.

- **Science:** UNESCO Global Geo-parks are extraordinary zones where the land heritage, or geo-diversity, is of worldwide significance. UNESCO Global Geo-parks are subsequently urged to work with scholarly foundations to take part in dynamic logical research in the Earth Sciences, and different teaches as suitable, to propel our insight about the Earth and its procedures. An UNESCO Global Geo-park isn't a historical centre, it is a dynamic lab where individuals can wind up occupied with science from the most astounding scholarly research level to the level of the inquisitive guest. An UNESCO Global Geo-park must take incredible care not to estrange people in general from science and use simple and understandable language on data sheets, signs, flyers, maps and books which are gone for the general population.
- **Culture:** The aphorism of UNESCO Global Geo-parks is "*Celebrating Earth Heritage, Sustaining Local Communities*" (<http://www.unesco.org>). UNESCO Global Geo-parks are generally about individuals and about investigating and praising the connections between our groups and the Earth. The Earth has formed our identity: it has melded our cultivating rehearses, the building materials and techniques we have utilized for our homes, even our folklore, old stories and society customs. UNESCO Global Geo-parks in this way take part in a scope of exercises to commend these connections. Numerous UNESCO Global Geo-parks have solid connects to expressions of the human experience groups where the cooperative energy discharged by bringing science and human expressions together can yield amazing outcomes.
- **Women:** UNESCO Global Geo-parks have a solid underline on engaging women whether through focussed instruction programs or through the improvement of women's cooperatives. UNESCO Global Geo-parks are a stage for the advancement, supporting and advancement of small scale industry and art products. In some UNESCO Global Geo-parks women's cooperatives likewise give a chance to women to get extra wage in their own territory and on their own terms.
- **Sustainable development:** Regardless of whether a region has extraordinary, world-acclaimed geo heritage of exceptional general esteem it can't be an UNESCO Global Geo-park unless the region likewise has an arrangement for the supportable improvement of local population who live there. This may

appear as sustainable tourism through, for instance, the improvement of strolling or cycling trails, preparing of neighbourhood individuals to go about as aides, empowering tourism and settlement suppliers to take after global best practice in natural manageability. Be that as it may, it can likewise be about just captivating with neighbourhood individuals and regarding their conventional lifestyle in a way that enables them and regards their human rights and nobility. Unless an UNESCO Global Geo-park has the help of neighbourhood individuals it won't succeed. UNESCO Global Geo-park status does not infer confinements on any monetary action inside an UNESCO Global Geo-park where that action follows indigenous, neighbourhood, provincial or potentially national enactment.

- **Local and indigenous Knowledge:** UNESCO Global Geo-parks effectively include nearby and indigenous people groups, saving and praising their way of life. By including nearby and indigenous groups, UNESCO Global Geo-parks perceive the significance of these groups, their way of life and the connection between these groups and their land. It is one of the criteria of UNESCO Global Geo-parks to include local indigenous knowledge alongside science in the planning and management of the area.
- **Geo-conservation:** UNESCO Global Geo-parks are region that utilization the idea of sustainability, value the heritage of Mother Earth and perceive the need to secure it. The characterizing geographical region in UNESCO Global Geo-parks are ensured by indigenous, neighbourhood, provincial as well as national law and administration specialists, in collaboration with the suitable organizations, which consider the vital checking and upkeep of these locales. Suitable assurance measures for each site are set out in singular site administration designs. The administration body of an UNESCO Global Geo-park will likewise not take part specifically in the offer of topographical protests, for example, fossils, minerals, cleaned rocks and elaborate rocks of the sort ordinarily found in alleged "Rock shops" inside the region, and numerous effectively debilitate unsustainable exchange of any geo matters. It doesn't allude to material for ordinary mechanical and family unit utilize which is sourced by quarrying as well as mining and which will be liable to control

under national and additionally global enactment. In specific situations and where unmistakably supported as a mindful action the administration body may allow practical gathering of land materials for UNESCO Global Geo-park. Exchange of topographical materials (as per national enactment on Earth heritage protection) in light of such a framework might be endured in extraordinary conditions, if it is plainly and openly clarified, defended and observed as the best choice for the UNESCO Global Geo-park in connection to nearby conditions. Such conditions will be liable to verbal confrontation and endorsement on a case by case premise.

2.1.4 Larger sustainable development goals:

Geo park improvement is an enormous measure of speculation for the developing country, therefore the UNESCO has centre the advancement of such park economically which help the physical and social setting of the recreation centre site. Here are the objectives, which are recommended by the UNESCO to make the improvement sustainable. The goals and focus area listed below.

- **Goal 1: Poverty**

Particularly By 2030, form the flexibility of poor people and those in defenceless circumstances and diminish their presentation and helplessness to extremity of climate related threat and other monetary, environmental, and social shocks. Reducing the risk of disasters are generating awareness for the same is one of the helpful idea for controlling the poverty during natural calamities. The base up approach of the UNESCO Global Geo-parks teaches the defencelessness of nearby groups to outrageous occasions and different stuns and debacles through dynamic hazard mindfulness and strength preparing.

- **Goal 2: Quality education**

UNESCO Global Geo-parks actively educate the local communities and the visitors of all ages. *“UNESCO Global Geo-parks are outdoor classrooms and incubators for sustainable development, sustainable lifestyles, appreciation of cultural diversity, and the promotion of peace”* (<http://www.unesco.org>).

- **Goal 3: Sustainable economic growth**

The advancement of reasonable nearby monetary improvement through practical (geo)tourism is one of the key mainstays of an UNESCO Global Geo-park. This makes openings for work for the nearby groups through tourism, yet in addition through the advancement of local culture and items.

- **Goal 4: Resilient city and human Settlement**

Security, defending and praising our social and characteristic heritage are the establishment of the all-encompassing methodology of the UNESCO Global Geo-parks. UNESCO Global Geo-parks intend to give neighbourhood individuals a feeling of pride in their region and emphasis their identity with the region.

- **Goal 5: Sustainable use of resources**

UNESCO Global Geo-parks teach and make mindfulness on manageable advancement and ways of life. They educate the neighbourhood groups and guests to live in concordance with nature.

- **Goal 6: Combat climate change and its impacts.**

All UNESCO Global Geo-parks hold records of past environmental change and are teachers on current environmental change. Through instructive exercises awareness is raised on the issue and individuals are given learning to relieve and adjust to the impacts of environmental change.

Worldwide Network of National Geo-parks upheld by UNESCO must be correlative exercises to the 'World Heritage' and the 'Man and the Biosphere Reserve' programme designer. The Global Geo-parks Network has 38 individuals from 12 nations. There are three noteworthy systems of the Geo-park bolstered by GGN.

1. European Geo-parks Networks
2. Asia pacific Geo-parks Networks
3. Transnational Global Geo-parks

Other than UNESCO, the International Union for Conservation of Nature (IUCN) likewise underpins Geo-park movement through various nature preservation and administration on different scales. IUCN protected areas are classified as per the management goal for the particular sites. As indicated by IUCN the class III which centre around the natural monumental sites fits for the Khari River gorge landscape.

2.2 IUCN category iii

Selected area put aside to ensure a protection of the natural features, which can be a landform, ocean mount, submarine natural caves, topographical element, for example, a give in or even a living element, for example, an antiquated forest sacred grooves. They are for the most part very little secured regions and frequently have high guest esteem (IUCN, 2018).

2.2.1 Primary objective

The primary objective is to secure distinguishing natural features and their related biodiversity and territories.

Other goals:

- To give biodiversity protection in landscapes or seascapes that has generally experienced significant changes;
- To ensure particular regular destinations with profound and additionally social qualities where these likewise have biodiversity esteems;
- To ration conventional profound and social estimations of the site.

2.2.2 Distinguishing features

Classification III secured sites are generally small, it mostly gives attention on one conspicuous natural feature and the related ecology, instead of on a more extensive ecosystem. The expression "natural" as utilized here can allude to both completely natural features yet in addition to that now it features the site that have been modified by people. In the last case, these destinations ought to likewise dependably have critical related biodiversity traits, which ought to be reflected as a need in their administration goals on the off chance that they are to be delegated protected area as opposed to sacred sites. Classification III ensured territories could include:

- Geological and geomorphological highlights, for example, waterfalls, caves, craters, fossil beds, sand ridges, rock forms valleys and marine structures, for example, ocean mounts or coral developments.
- Culturally-affected natural features, for example, caves painting and dwelling area, ancient trails and tracks.
- Natural-social destinations, for example, the numerous types of scared and spiritual sites in nature. (Old forests, springs, waterfalls, mountains,

ocean bays and so on.) When sites are important to ethnic groups.

- Cultural sites which influences ecology: where archaeological/heritage destinations that are inseparably connected to a natural features or unique characteristic of site.

Nature preservation traits of classification III ensured region fall into two fundamental composes:

The Biodiversity which is priceless with the unique ecological condition surrounded to it –, for example, the splash zones of a waterfall, the biological conditions inside the caves or plant species limited to cliffs. Biodiversity that is surviving in because of cultural or spiritual values are attached to such site, and otherwise site identities are highly vulnerable to the recent changes.

In these cases, the key criteria for incorporation as an ensured safety of the region will be

- (I) Assessing the attached value of the area as a commitment to wide scale preservation and
- (II) Prioritization of biodiversity protection inside administration designs.

Classification III has been promoting for protection of many unique sites, for example, sacred grooves in forests. The classification III has supported many geological monument protections. Protection and management of these sites usually focus on maintain the uniqueness of the site.

2.3 Selected approach to design geo-park for khari river gorge Kutch, Gujarat.

1. *Eco revelatory approach – for the design the park and management of landscape*
2. *Visitor's management – through outdoor recreational activities planning.*

2.3.1 Eco revelatory design approach:

Assembled situations disregard individuals' need and possibility of for learning environment. The negative effects are identified due to unresponsive behaviour towards nature in human advancement are evident. Making environmental process and cycle noticeable in design can outline condition back to life. Effective planning

can educate us of our place inside the nature. In the history, Landscape architects have developed hypotheses and strategies which is ecological approach towards designing and planning. Eco-revelatory design (ERD) is also based on ecological planning idea which signifies "an outline system that endeavours to improve site environments also as engage users and visitors by uncovering natural and social, cultural system and process that forming the landscape (Arisoy, 2013)."

2.3.2 Eco-Revelatory Design

In 1998 a gathering of experts and landscape researchers distributed a unique issue of Landscape Journal as an inventory and record of the display Eco-Revelatory Design: Nature Constructed/Nature Revealed. Issue was edited by Brenda Brown, Terry Harkness, and Douglas Johnston. The ERD exhibition was led by three of them. The proposition developed as a response to the present setting where a gap between ecological outline and purely aesthetic based landscape designs. The promoters of ERD also saw the weakness in of absolute environmental and ecological planning in its absence of "investigations of straightforwardness and translation," and additionally "The associated garden design values like – symbolism, abstraction, imagination". In like manner, they censured the disregard of genuine environmental issues in the landscapes concentrated on style, imagery, and understanding. Advocates of ERD recommend that as the undeniably fast change of the American landscape proceeds with, *"much need and potential exist for plan that uncovers and translates ecological systems, procedures and connections—what we are calling Eco Revelatory Design"* (Brown B. H., 1998). The principal perceives ERD as an instrument for ecological training where the landscape goes about as a medium for the exchange of information, both through direct understanding and translation. Intervention in landscapes can feature highlights and forms to make an elevated feeling of mindfulness and association with the site. An imperative fundamental suspicion made here is *"If one is more aware of environmental phenomena and processes—if one is able to see and comprehend them—one is better able to appreciate, evaluate, and make wise decisions concerning them"* (Brown B. H., 1998).

The second phenomena for ERD lie in the potential for landscape designers to investigate new domains of innovative environmental articulation. In incorporating

the openness, symbology, interpretation, and reflection of the customary garden into ecological planning, there lies a significant inactive potential for landscape architect to convey what needs be as interpreters from environmental process to make them recognisable. In an accumulation of articles on phenomenological ecology, David Seamon discussed about social arrangement and environmental policy outlines get fail today since they are established on the triviality and constrained contact of association as opposed to on the profundity and authentic contact of relationship. This sets the phase for plan that reinforces the connection amongst individuals and the environment, and makes ERD an auspicious and essential undertaking for landscape designs. Yet, in what capacity would designers be able to accomplish revelation of ecology in their design? One approach to connect people individuals to nature through elevated stimulating experience.

2.3.3 Principles (design strategy)

The creators of Eco-Revelatory Design proposed hypothesis that, to design is to uncover and translate the natural and ecological process and connections of site to users and visitors. There are many strategies they have defined to by which one can clarify design procedure.

1. Abstraction and interpretation of nature environment in design
2. Changing the existing use of landscapes delivering further nurturing life and natural processes
3. Signifying highlights that represent cultural or natural process that may somehow stay imperceptible
4. Revealing the landscape through infrastructures
5. Reclaiming the history of the landscape in present so the past is recalled
6. Change points of view by organizing how we collaborate with the Landscape.

In this thesis, I am exploring the first strategy of interpretive design as a method to reveal meaning and significations of the site. Interpretation is art of explaining through which visitors can perceive beauty that lies behind in the landscape.

2.3.4 Interpretative Planning

There are 3 key components of the interpretive planning, which are again asked by the questions. Answering these questions has helped me in making the frame work of the design.

1. What to interpret? - Significance of the site which will be experienced at direct by the guests.
2. for whom to interpret? – Type of visitors is important to understand the planning of the recreational area. Whether they area vacationers, day guest or occupants, making a recreational visit.
3. How to interpret? - The association or individual translating the site intends to create awareness amongst visitors for its preservation and additionally to support recreation activity that program offers.

2.3.5 Visitor experience

Interpretive planning is a procedure that recognizes and portrays recreational experience in the natural areas and parks like, forest, water fronts or other asset based recreational zone. Interpretative approaches energize, manage, encourage, or generally help recreational experiences. Everything that stimulates visitors experience including what they think, sense, and feel in a recreation area constitutes from their understanding. Interpretive planning involves different techniques to exhibit the story and revelation of nature through different media. A portion of these suggestions involve interpretive media or exercises; a few encounters are encouraged through only design outline by simply escaping the way. While anticipating interpretive or guests encounter base action few root level inquiry one has to consider (Planning, 1998).

1. What are significant feature of this landscape and why it is set out to develop as park?
2. What is the considerable experience that visitors must feel when they visit the park? (What will guests need to do, feel, learns, involvement; and so on?)
3. What are present conditions influencing visitors experience and translation? What are the basic stories and encounters to make accessible to neighbours? What are the laws, orders, strategies or rules that influence this undertaking? What data and natural assets are accessible, and what are required?

4. What are noteworthy connections amongst natural assets and guests? What are key issues?
5. How can the organization make attractive encounters more open to more visitors?
6. What are obstacles to visitors can face while enjoying the landscape? Should the organizing coordinate or divert guest's inspirations and desires? In what capacity can the organization serve assorted groups of observers?
7. How can designer make control over the shady activities which can do adverse impact on landscape and can be problems to other visitors? What are the advance strategies to upgrade asset assurance and guest satisfaction?
8. How can the designer make the planning sustainable, easy of maintenance for long time at controlled cost?

INTERPRETIVE PLANNING WILL HELP PARK STAFF:

- Develop accord on a long-go vision for landscape interpretation and experience for visitors
- Provide key guest encounters while securing natural assets and improving stewardship
- Develop the most practical and economical answers for visitors and landscape issues
- Effectively utilize translation and instruction to meet administration objectives (yields and outcomes) Fulfil orders to serve the general population and ensure health of the landscape.
- Good interpretive design guarantees that significant value of the park and experience are available to visitors, with conservation objectives.

CHAPTER 3: CASE STUDY

3.1 Eco- Revelatory approach

Foothill Mountain Observatory: Reconsidering Golden Mountain by Terry Harkness

The Foothill Mountain Observatory is a landscape observatory: It gives a focal point, an experiential window onto the landscape of southern California. The recreation park is intended to locus the perception and experience of natural characteristic and cultural relationship of landscape. The at one hand the landscape has natural phenomena of Rivers and River flood, mountain and hill erosion, regular dry season and fire where at cultural front landscape exhibit, labours work of human on modifying the landscape; for harvest and yield, for abuse and care. This current landscape's history and its progression take the eye of the designer. Understanding is based on issue of Landscape journal issue (Harkness, 1998).

A semiarid Mediterranean atmosphere of sun, dry season, Santa Ana winds and winter rainstorms, surprising and irregular quakes, wild chaparral fires, trash streams and mud slides are overlaid by a long history of culture in this landscape - early Indian consuming of spring fields, farmers settling and guarding the lower region gorge to collect the valuable water streams, the little 10-to 20-acres of land citrus farming of agrarian care, and the ages visitors to come and experience "golden mountain." The observatory's design strategy is to make the contrasting landscape work for visitors to understand observe the difference of surrounding contextual of the landscape and alters agrarian landscape of park site. An orchardist agrarian model provides a relative edge between the encompassing deep theoretical tract improvement and the landscape observatory itself. Rural advancement, the recreation of the vanished citrus culture, the interpretative area exists together with the goal that one can analyse past, present, and future narratives. The recreation park is at the San Gabriel range's crossing point of geologies, topographic orders, and vegetative administrations. Visitor experience development and assembled structures sew mountain range to valley, and mountain ridges to gorge landform. After careful understanding of geology, soil and hydrology of the site trails, walk ways and terraces were made. The visitors is conveyed to the edge of the water, gorge opening and valley alluvial statement, plant age, fire demolition, and plant

reforestation. Water is the crucial measure by which geologic process, vegetative determination, and geology are comprehended. Water's movement can erode and collect and move the matter towards gravitational force. Water can recharge and rejuvenate the landscape and people. Movement of the Water is uncovered and revealed from its unconstrained form to managed and manipulated form. Vegetation composes identify with topographic and dampness, break lines with local and introduced species zoned as water available and conservation goal.

Vegetation and water utilize are explored on slopes and on Hydric, mesic to xeric habitat. The park distills California's water history and the vegetative history of local and introduced species. Late enormous modifications have deleted numerous southern California landscapes that discussed contending human and regular conceivable outcomes. The Foothill Mountain Observatory reconsiders and refocuses on prompt, nearby procedures that ground our experience, utilize, and care of this heritage. Living on the cliff, this park can uncover as every day experiences this provincial landscape's coherence and its evolving articulation.

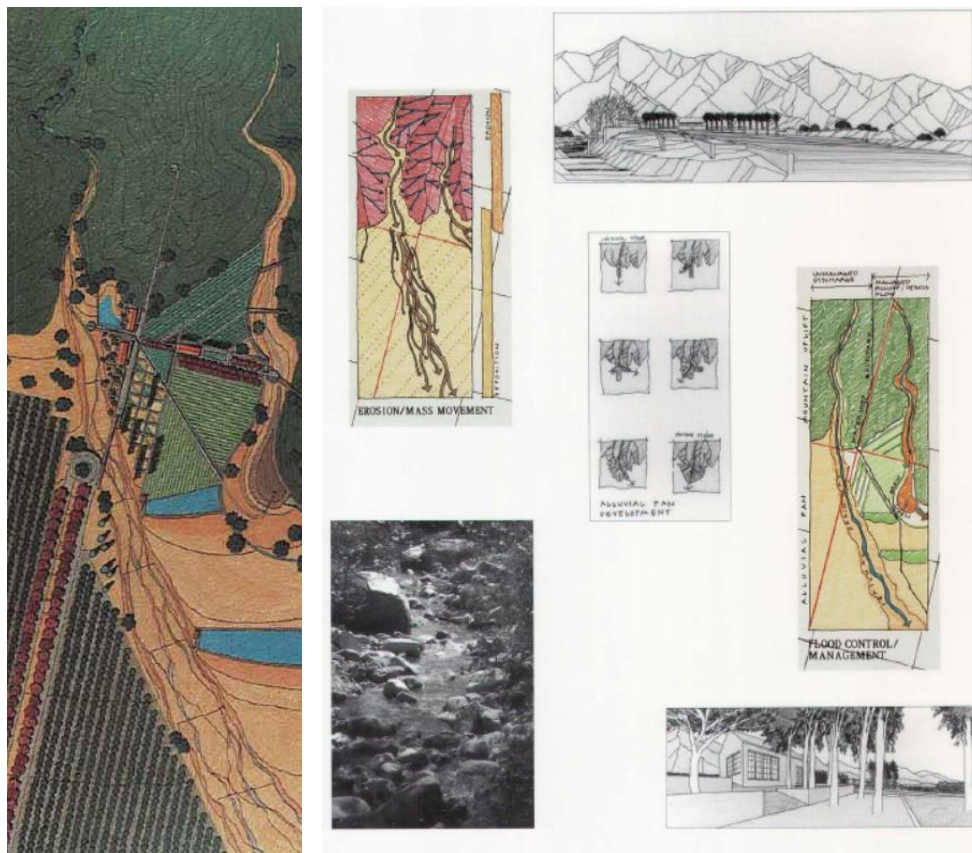


Figure 1 Park Master Plan and Analysis

Landscape architect Terry Harkness work, Source: Landscape journal

3.2 Case study – Indian context

RaoJodha Desert Park

Situated in the city of Jodhpur, on the edge of desert, RaoJodha Desert Park is an environmentally re-established landscape park, opened to people in 2008. It is situated on the outcrops of volcanic rocks along with saline sand. The hot and dry climatic condition encourages the solid breezes which shape the stones and hills, rendering a unique 'dry and eroded' character of the landscape. The project imparts its limits to the sixteenth century fortification wall, and it is spread over 70 hectares. The site history of quarrying and excavation of rock has degraded the landscape and environment made it waste land. The park was once the part of 400 Hectare of no man's land which only thorny scrubland of desert. The current vegetation, natural soil condition and climatic condition made it troublesome for the recovery venture where the designer was given the task of re-establishing the wasteland, to its native vegetation to preserve its natural value. Understanding is based on paper (Manna, 2015).

The desert park landscape is full of rocks lithophyte development. The reclamation for the recreation park was begun in 2005-06 starting with condition mapping of vegetation, water, and soil. The landscape was suffering from invasive species name *Prosopis Juliflora* for long time; it had decreased the growth of the any local vegetation.

The designer included the group of local community in removal of the *Prosopis Juliflora* specie as the local community had the customary ability in mining in the hard rock of the park area. In first phase of the project task was to create landscape gaps by removing the invasive species. The next phase of the undertaking was to make a detail plant list of local area, which would keep the help in preservation goal. The collection investigation of plant species helped in recognizing the habitat similar to park area and its possibility for restoration. Designer developed new areas and turned them into the 'clone' of the habitat, it gave 80 new species, which were transplanted back in the underlying landscape gaps. The site has historical landscape elements like terraces and an old water channel. In planting strategy the use of lithophytes can be observed along the rocky terraces and trails for visitors observed. At the beginning point of park additional information is revealed through

CHAPTER 3: CASE STUDY

exhibiting the rough stone secured with desert grasses and lithophytes which change character in rainy seasons. The park offers are different kind of experience as there are many types of gardens in it – memorial, lake and park also give insights about the geological formation of rock in the park. This biological or ecological mimic of the desert vegetation attract many birds and animals of desert area. territories of little leave creatures and winged animals.



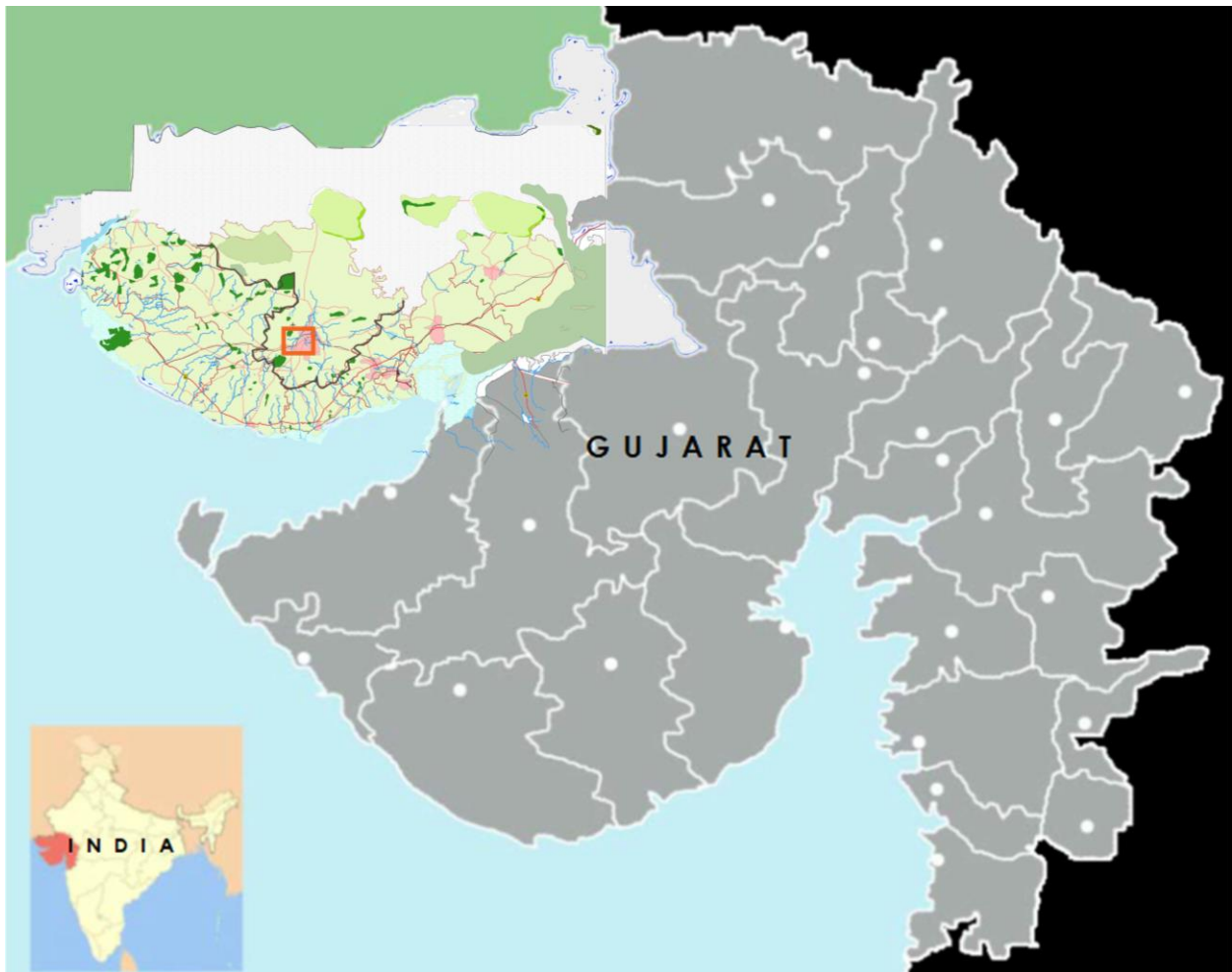
Figure 2 Understanding of Rao Jodha Park

Source: Author

CHAPTER 4: SITE DOCUMENTATION

4.1 Location:

Kutch is situated on the western coast of India between 20°06' to 24°42' north latitudes and 68°10'N to 74 ° 28' east longitudes. Kutch is one of the largest districts of the India with a total geographical area of 45,652 square kilometres. Kutch is unique geography land because of its location, it is a located between the Great deserts of India - Sind and Thar and the Arabian Sea. It has a 1600 km long coastline. Its northern boundary forms the international boundary with Pakistan. The major part of Kutch landmass gets covered with salt and mud flats during monsoon. As Rann of Kutch is surrounded by sea, which get flooded during monsoon, and create island, swamps, and salt marshes. It is a place with spectacular ephemeral ecology and geological monuments.

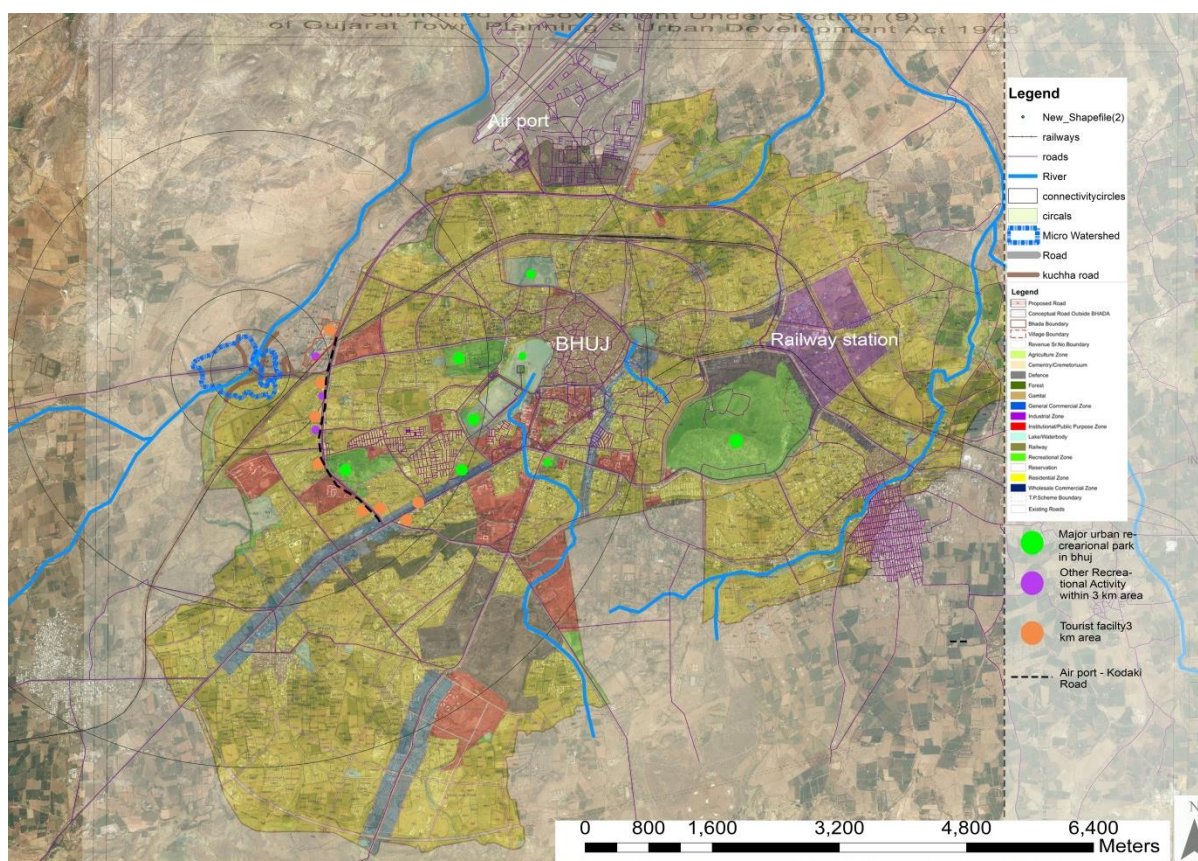


Map 3 Kutch district map

Source: Author

4.1.1 Site surrounding and immediate context

Location of site in Bhuj city limits area. The plan is showing overlapping of google earth map with development plan of the city area. The marked watershed boundary is passing the city limit fringe area. The Khari River gorge is located 4 km west from the Bhuj town on Bhuj-Kodaki road. Site is surrounded by mainly farmlands, vegetation along buffers and upcoming residential development as per the development plan. In just 1.5 km radius of the site the main connecting road between Bhuj and Kodaki village is there. The Airport road is 2 km from the gorge. Air road has many tourist facilities which attracts many tourist throughout the tourist season of Oct - February, Hotels, eateries and transport. The airport road also attracts many locals throughout the year urban recreation opportunity like multiplex eateries, amusement park known as hill Garden, festival grounds and polytechnic university.



Map 4 Bhuj City Development Plan

Source: Author

4.2 Demographics

The Current population of the Bhuj Taluka and urban centre is listed below. The taluka population can help in determined possible visitors on monthly bases whereas the urban population helps to understand the visitor's numbers during weekends.

Population:

- Bhuj Taluka population - 443288 persons with, average Growth rate of 27.56%.
- The population of the urban area is about - 220949.713 with average Growth rate of 36.84%.

Other than local and nearby visitors, this park is expecting tourist flow. The major tourist inflow is observed during winter season in month of October to march. Here is the historical data of the visitors for Bhuj city and district is described below in the figure, received from Gujarat tourism department.

Overnight Tourist Flow in Kutch			
(Fig in lacs)			
Destination	2011-12	2015-16	2016-17
Monthly Surveyed Destination			
Bhuj	2.55	5.02	5.85
Gandhidham	2.54	3.51	3.85
Mundra	0.66	0.65	0.80
Mandvi	1.00	1.37	1.65
Kutch Rann	NA	0.63	0.94
Sub Total	6.75	11.18	13.09
Yearly Surveyed Destination			
Narayan Sarovar	4.43	1.72	1.56
Matano Madh	4.00	0.88	0.77
Bhadreshwar	NA	0.73	0.59
72 Jinalay	NA	0.53	0.49
Sub Total	5.24	3.86	3.41
Non Surveyed Destination	0.69	7.30	7.45
Total Tourist Flow	15.93	22.34	23.95

Source: TCGL GITCO, Tourist Flow Information System (TFIS)

Bhuj city Land-mark, and tourist number.

1. Pragmahal - 1.3 lakcs ppl in year (2016-17)
2. Darbar gadh mahel, Bhuj- 2.2 lacs ppl in year (2016-17)

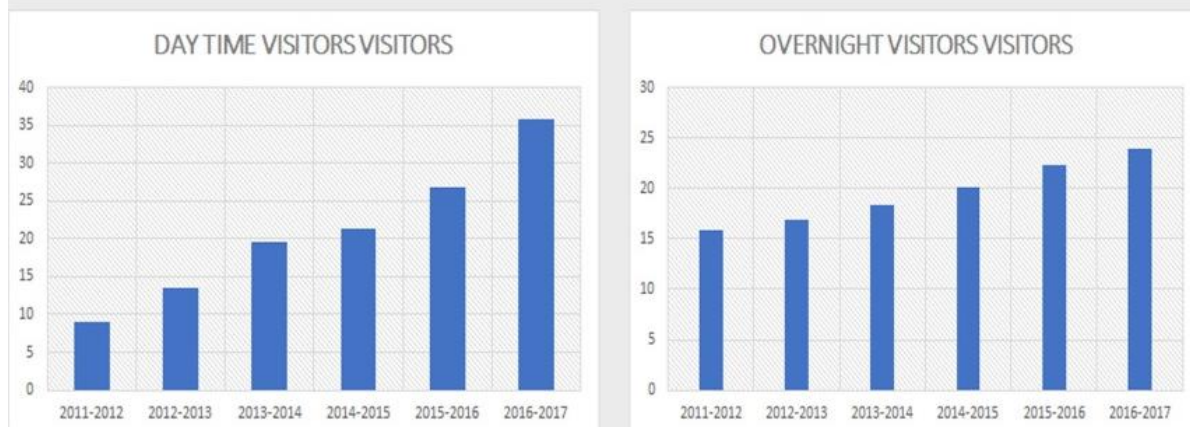


Figure 3 Tourist Data for Kutch District

Source: TCGL, GITCO, Tourist Flow Information system, Gandhinagar Office

4.3 Climate

The climate of Kutch is mixed and can be divided into three seasons: Hot and moistures season which lasts for three months of - July to Sep. Kutch is known for extreme Cold and Dry season which lasts for - Octobers to February. During summer season the climate becomes Hot and dry, it has the longest duration of the year with the months of - March to June. In winter season temperatures are comfortable with averages between 12°C and 27°C. During summers average temperatures range between 25°C and 43°C with extremes of 48°C. Kutch is among the hottest district of India. In Rann of Kutch extreme climate can be experienced, in summer temperatures reach to 49.5°C and during winter they get reduced and can go below 0°C.

In Bhuj city maximum temperature can be experienced in the month of May which exceeds more than 45°C. Where January is the coldest month of the year when temperature drops down to 8°C. Bhuj expects rain from the South-west Monsoon. It only rains for 3 months with very limited rain of 15 – 25 days. These episodic rains are of only 100 - 150 mm throughout the monsoon.



Figure 4 Climate Data

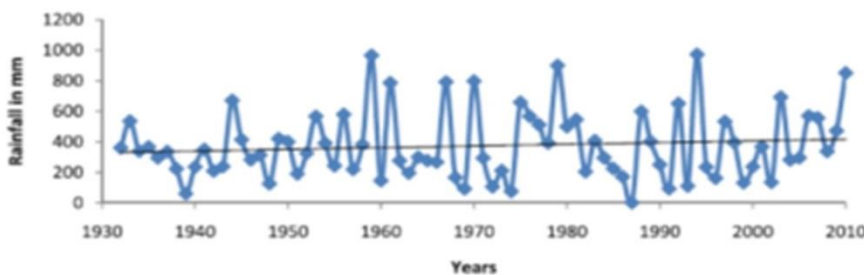


Figure 5 Rainfall Data

Source: World Weather online.com

4.4 Landscape mapping

In order to delineate site boundary the natural and anthropogenic features are mapped. The mapping of natural features includes physiography mapping, mapping of various natural layers which includes – geology, hydrology, and vegetation and lastly the mapping of the cultural feature is done.

4.4.1 Site boundary delineation:

For the study of the natural and cultural features of the boundary delineation is done based on the understanding of the watershed.

Watershed - According to United States Environmental Protection Agency (EPA), watershed is the area of land where all of the water that is under it or drains off of it goes into the same place (Anonymous, 2012b). A watershed is a catchment basin that is bound by topographic features, such as ridge tops (Anonymous, 2012c).

There are different sizes of the watershed area micro, small, and large watershed, understanding of it is described below.

1. Large Watershed - Large watersheds are those give peak flows are greatly influenced by channel characteristics and basin storage.
2. Small watersheds - Small watershed are those where the overland flow is the main contributor to peak runoff / flow and channel characteristic do not affect the overland flow.
3. Micro/Sub watershed - sub-watersheds (micro watersheds) are defined as catchment areas concerning drainage lines in various sizes which feed watersheds and river watersheds (Karadağ, 2007).

Figure 6 Watershed area and Micro watershed area

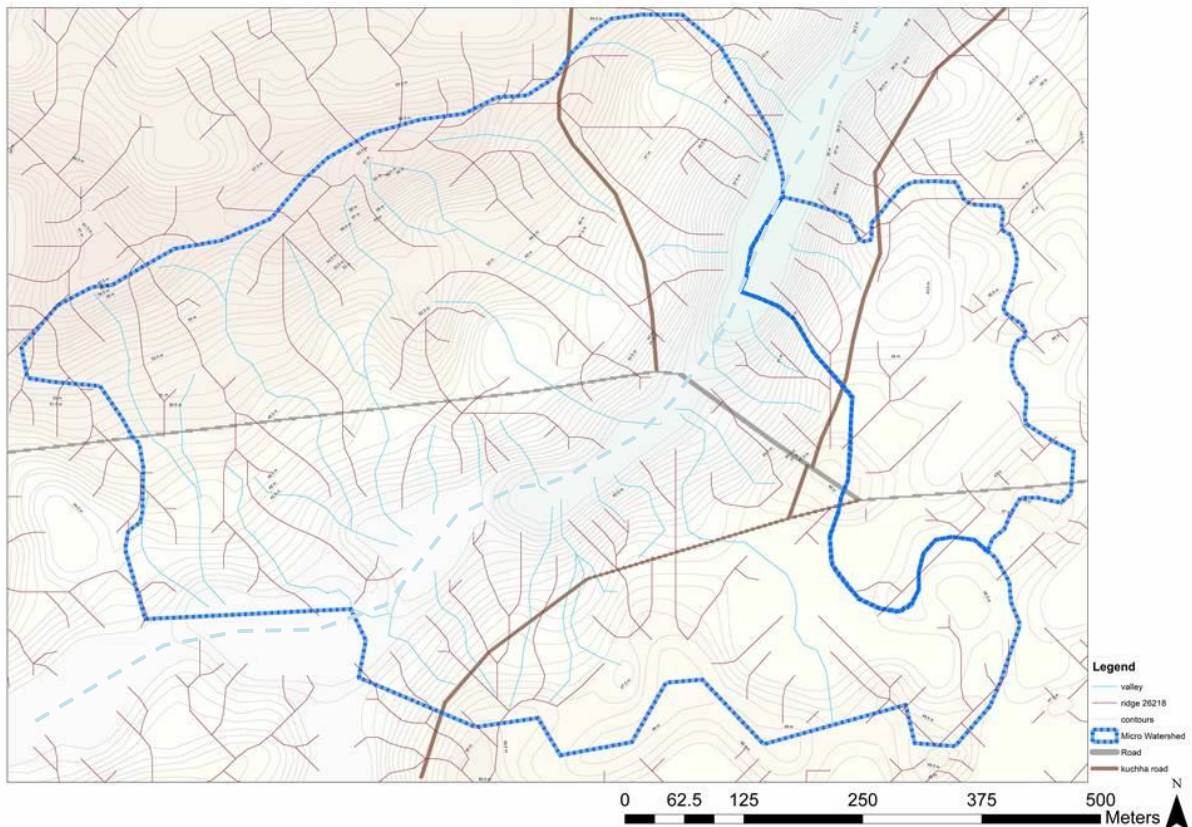
Source: Book - *Advances in Landscape Architecture*, Edited by Murat Ozyavuz

4.4.2 Physiography study:

In order to delineate watershed boundary the mapping of ridge and valley is required. Mapping of ridge and valley line is entirely based on the DEM (digital elevation model) which is processed to generate contours and others different natural features like – valley, understanding of the relief of the area, slope analysis of the site. These data was generated through the understanding of the software name Geographic information system. Ridge and valley mapping: watershed boundary is generated by connecting the ridge line of the area. The boundary is useful to understand the edge and extent of the study area. The rest of the study is done with focus of this boundary. Map is showing the blue lines which indicate the valley line and brown lines shows the ridge lines. Map shows that runoff is coming towards the central part of the micro watershed and the central area where Khari River is flowing

The mapping is done at the DEM resolution of the 12.5 metre. The sources of the DEM are the USGS online data downloads which are authentic sources of terrain information. The vegetation of the watershed area was mapped with Google earth imaginary of 2016 and the onsite observation and photographic documentation.

4.4.3 Micro watershed delineation:

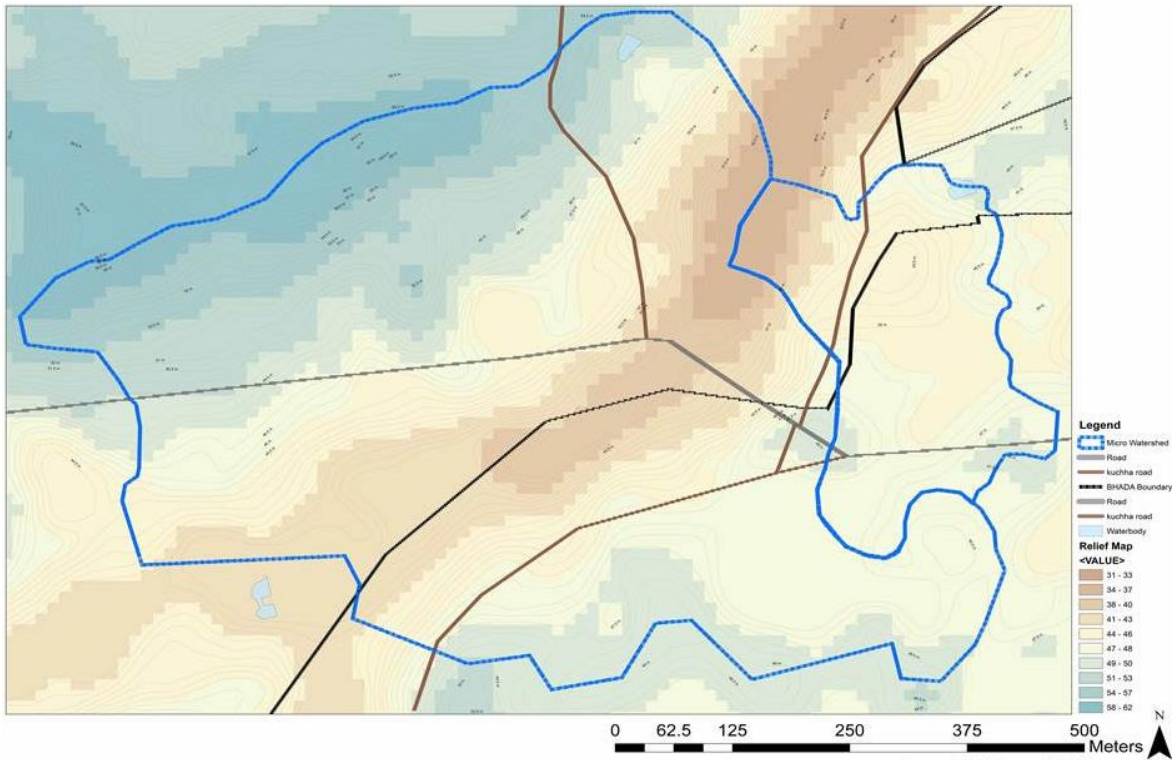


Map 5 Mapping of Ridge and Valley

Source: Author

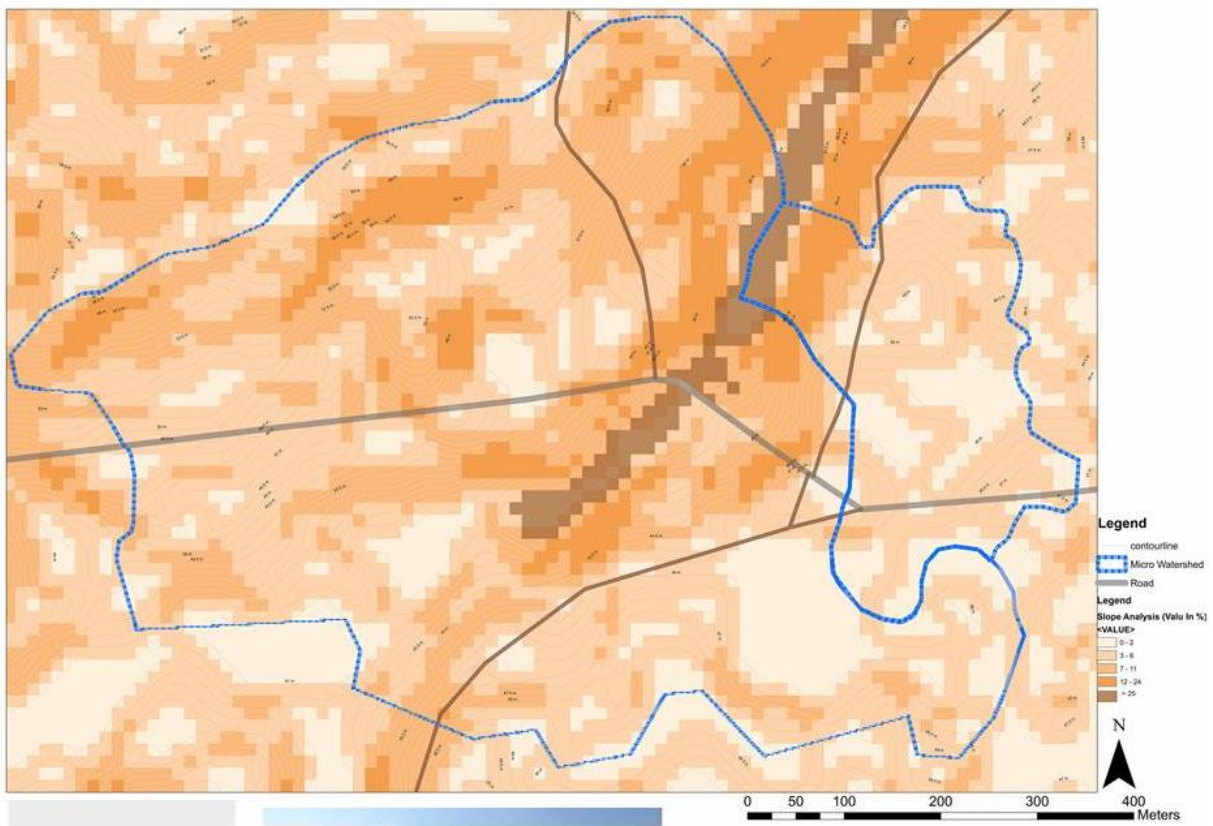
4.4.4 Relief map:

Selected micro watershed is at 100 meter above from the mean sea level. The micro watershed area relief map shows the total elevation difference of the 31 meters. The below relief map is made with elevation difference of 3 meters. The elevation difference is clearly showing the depression in the central part, where Khari River is flowing. The valley makes the highest difference in elevation at the edge of the micro watershed. That is the dyke and fault is visible. Which will be explained future in the report. Map showing in the image is prepared by author.



Map 6 Relief map

4.4.5 Slope analysis:



Map 7 Slope Analysis Map

Slope analysis map of the micro watershed shows that the upper elevation is comparatively normal slopes with 0 – 11% of the grade. Near the central valley the slopes are much steeper and one can find more than 25% of the grades in this zones. The map shows that the near River the erosion rate is very high that suggest that poor soil profile in the valley which is explain through texture map future in the report. Map showing in the image is prepared by author.

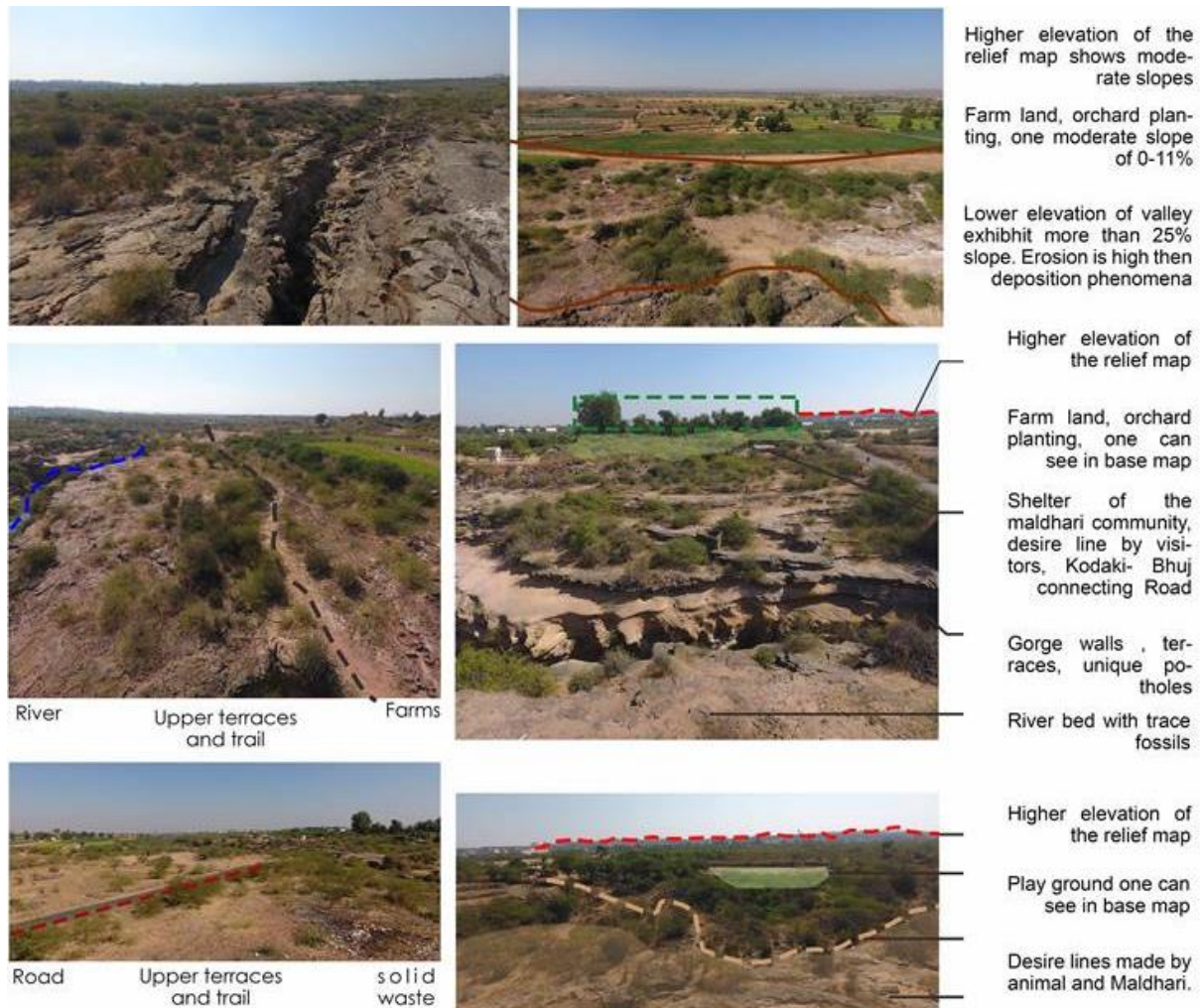


Figure 7 Site Images

Source: Author

In above figure once can observe the different character of the site.

Inferences:

1. All the valleys are meeting at the lowest elevation of the valley floor and hence it is the most eroded surface.
2. Valley floor has exposed bed rock and which has more slope of 25%.
3. At higher elevation soil can be observed.

4.5 Geology:

Khari River gorge is one of the miss fit landform in the according to current rainfall and climatic condition. The Gorge edge and eroded valley floors reveals the history of the evolution of the mysterious gorge landscape and geology of the Bhuj sandstone.

What is Gorge landform?

A gorge is a profound valley with steep rocks and cliffs on its sides. Generally River is flowing at gorge floor. That makes it a fluvial landform.

How is Gorge Formed?

Gorge is a fluvial landform, which formed due to high erosional activity. Generally gorge are formed by glacier cutting where water pressure is high or in the limestone geology where rock is soft, where River can slowly eroded the various layers of the limestone geology. Different kind of the erosional activity – wind erosion, water erosion and freeze melting can make the gorge more wide or deep.

Where Can a Gorge Be Found?

Gorges are generally found in hilly regions where there is glacier activity. They can also be found near desert plateaus where historically glacier activity was there. Here are the examples of the gorge landscape.



Figure 8 Granite Gorge, Colorado River

Source: <https://www.inaraft.com/holiday/royal-gorge-colorado-rafting/>



Figure 9 Royal Gorge Rafting – Arkansas River,

source - <https://www.inaraft.com/holiday/royal-gorge-colorado-rafting/>

4.5.1 Khari river gorge:

Khari River makes 20-25 meters deep gorge, and its length is roughly 400 meters. There are several terraces along with the gorge. The gorge is formed along with terraces. The terraces are made of Cretaceous sandstones and alluvial deposits. At

gorge the base level is relatively lower than the average height of the valley floor. The lowest point of gorge base is always filled with water, as per the primary survey, the water is so salty in the gorge area that, no locals use this water. One can observe the series of paired rocky terraces of varying morphologic features; some are studded with several large potholes and projecting directional erosional features like flutes and longitudinal grooves and ridges.

4.5.2 Khari River gorge Landscape evolution:

Landscape evolution Khari River in mainland Kutch happened during the Quaternary period. The cliff or vertical wall surface of the terraces reveals the history of the landform.

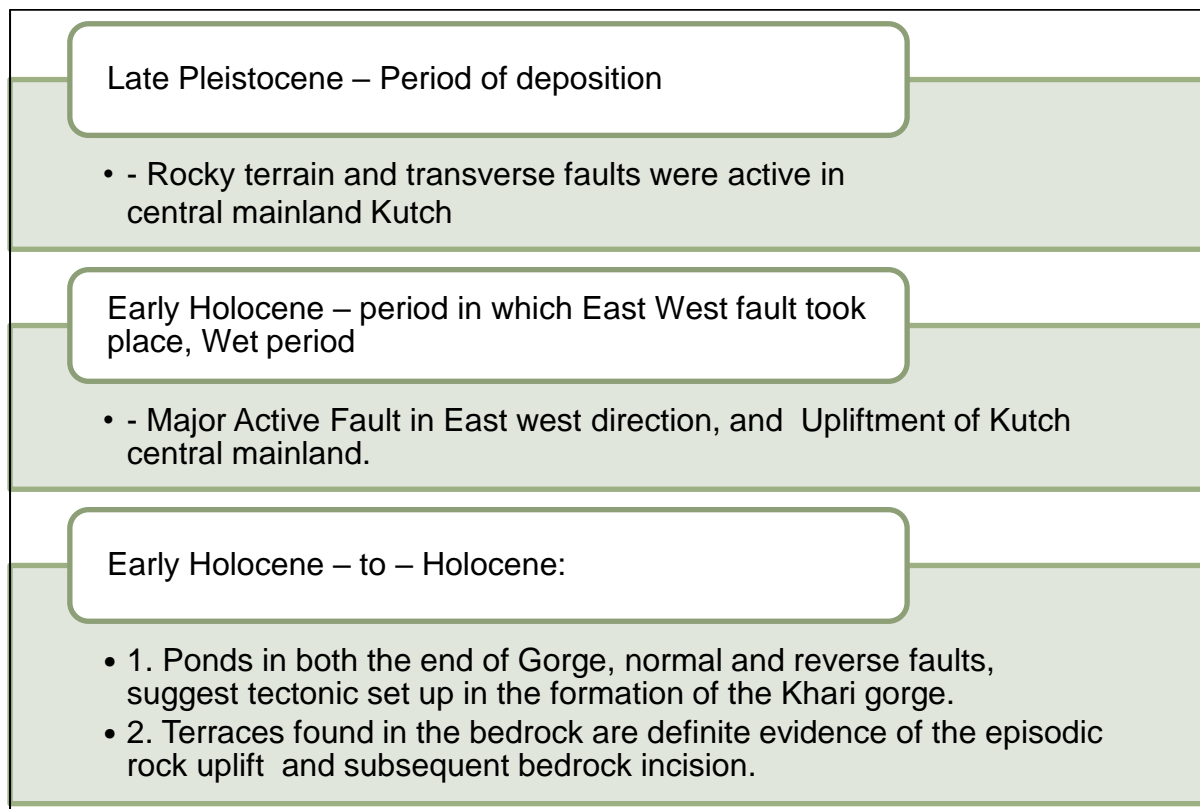


Figure 10 Landscape TimeLine

Source: Author

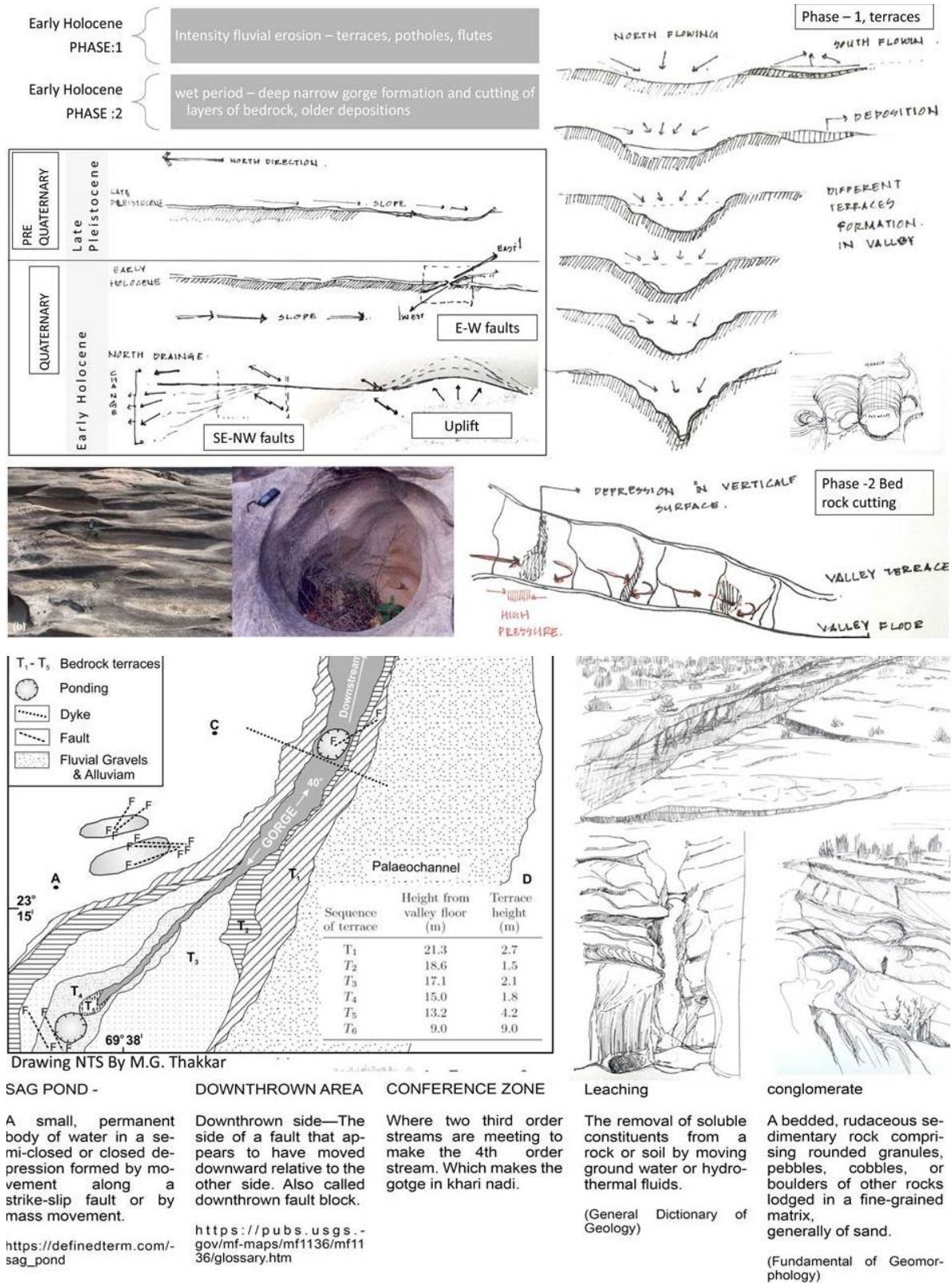
Reasons for different erosional surfaces: vertical plucking

- The obstacles on bedrock
- Disturbance in flow direction
- Water creates pressure on gorge wall against the flow direction.

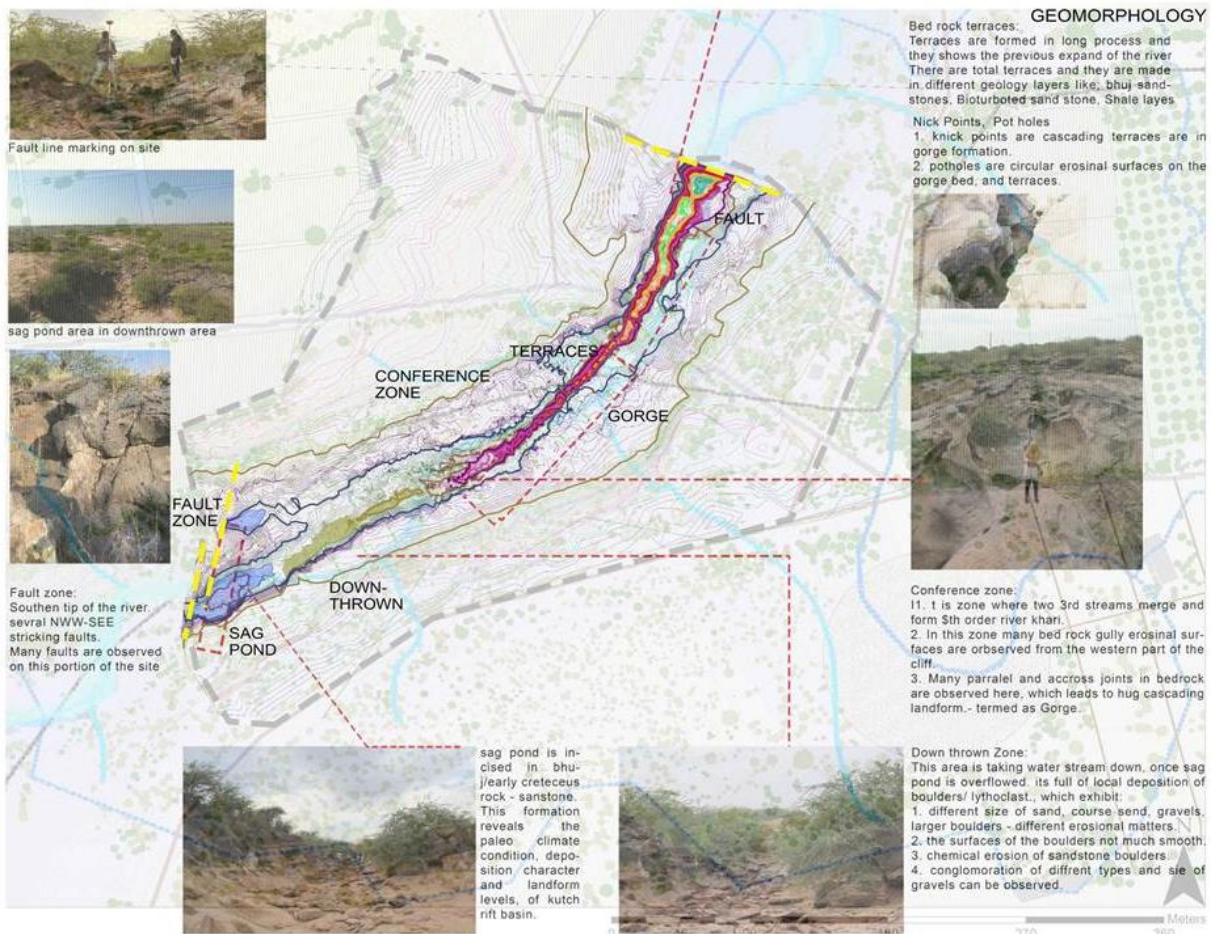
Reasons for different erosional surfaces: Development of flutings.

- Flutes or longitudinal grooves appear when bed rocks are massive in scale and material joints are not available for plucking.

CHAPTER 4: SITE DOCUMENTATION



4.5.3 Geomorphology map:



Map 8 Geomorphology of Khari river

Source: Author

The map is showing Geo morphology of the site and understanding of the different features of the landscape. Map is made by author after understanding the paper of Prof. M.G. Thakkar.



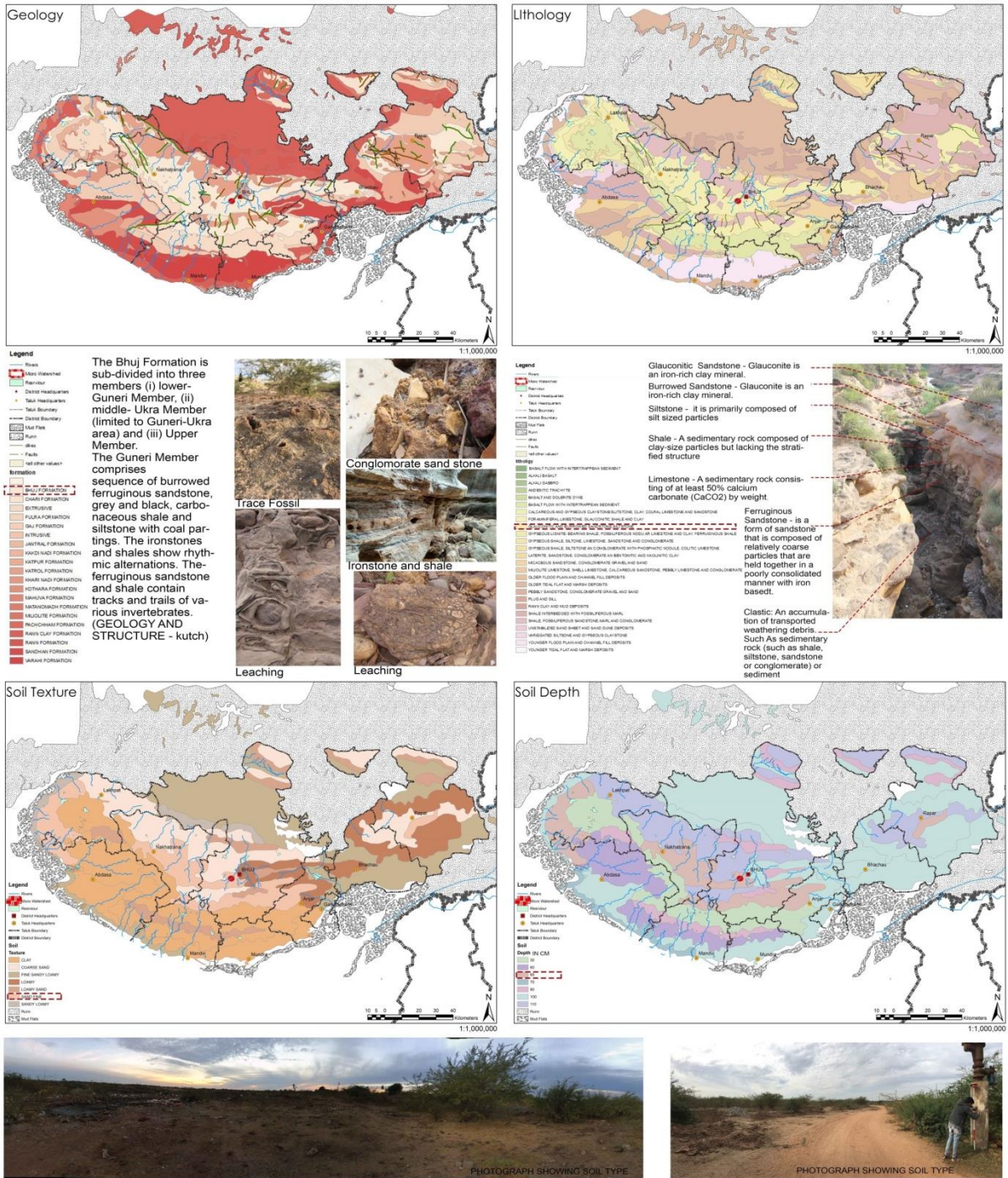
A terrace can be formed as a river cuts deeper into the land. A new, lower floodplain may then be established, leaving part of the former flood plain at a higher level as a terrace.
<http://worldlandforms.com/landforms/terrace/>
knickpoint - An interruption or break of slope, especially a break of slope in the long profile of a river.



Figure 12 site pictures

Source: Author

CHAPTER 4: SITE DOCUMENTATION



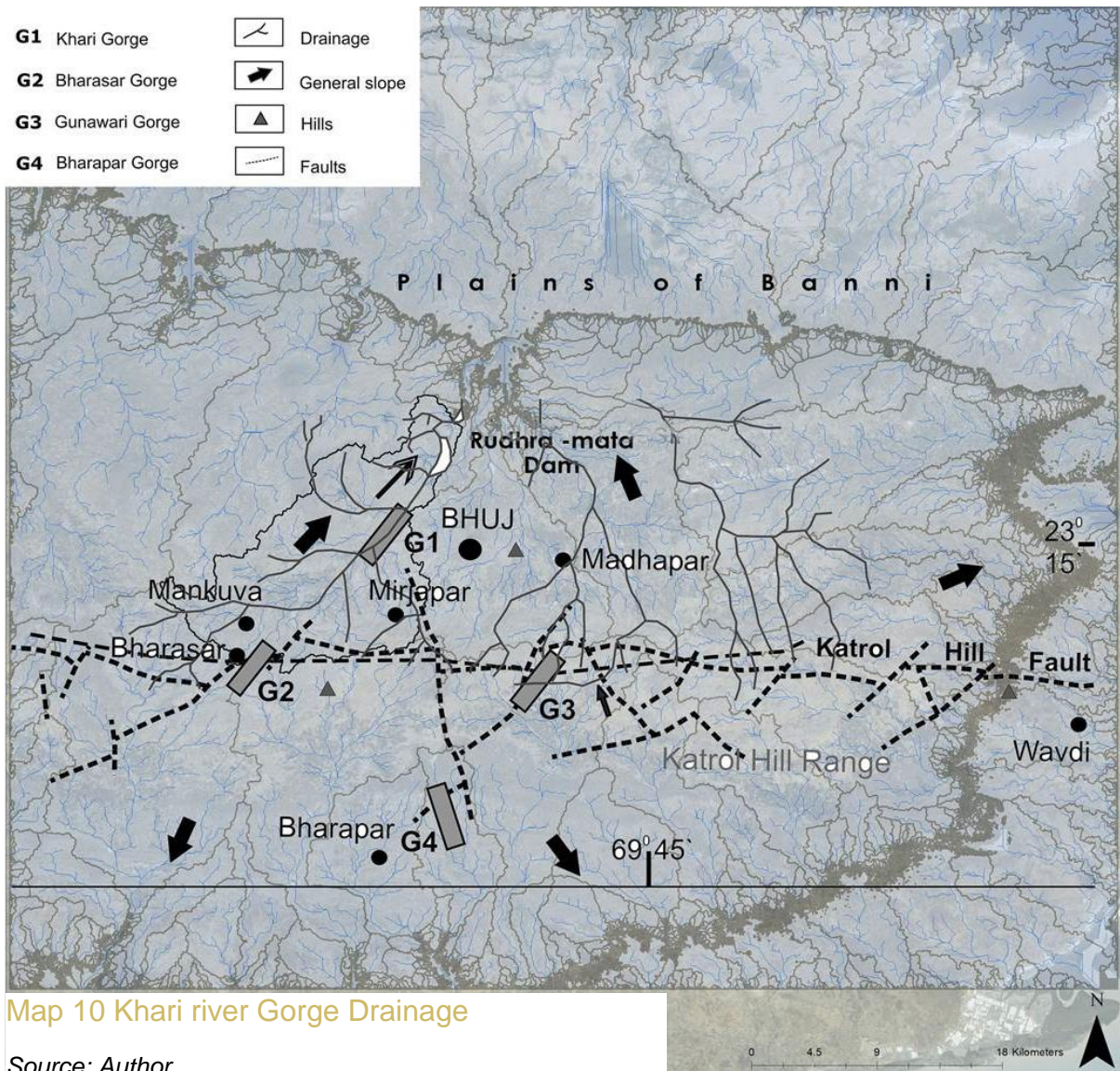
Map 9 Geology Map, Lithology map, Soil Depth map, Soil Texture map

Source: Author

There are various erosion processes example – Chemical weathering, fluvial erosion, that changes the rock form which one can see in the images. Available sandy fine type soil texture is predominant on site. It allows very few plant species to grow in the area. Watershed area suffers with very poor soil depth of only 65 centimetres.

4.6 Hydrology:

Khari River decants from Katrol hill ranges from the central part of the Kutch district and meet the Rann of the Kutch in North. Katrol Hill range divide the drainage system of the Kutch in two directions - north and south. Khari River mainly make dendritic flow pattern. Many of the River decent from the Katrol hill range makes bed rock gorge in mainland of Kutch. Map is showing the Khari River flowing from Katrol



hill range and gorge location at district level. There is similar mainland gorge in Bharapar and other two gorges are in hill rages. Map is showing the Khari River flowing from Katrol hill range and gorge location at district level. There is similar mainland gorge in Bharapar and other two gorges are in hill rages.

4.7 Vegetation:

As discussed earlier climate of Kutch is hyper arid and Khari River has poor soil profile. Majorly the Xeric habitat is found on the site. this includes many types of scrub and grasses. There are few hydric species are found on the terrace 3-6. On upper terraces where soil profile is poor one can find xeric habitat. The transition of the xeric to hydric habitat is sudden in the cross section of the valley. Mesic habitat can be observed on the recent alluvial deposits on the edge of the farmlands and

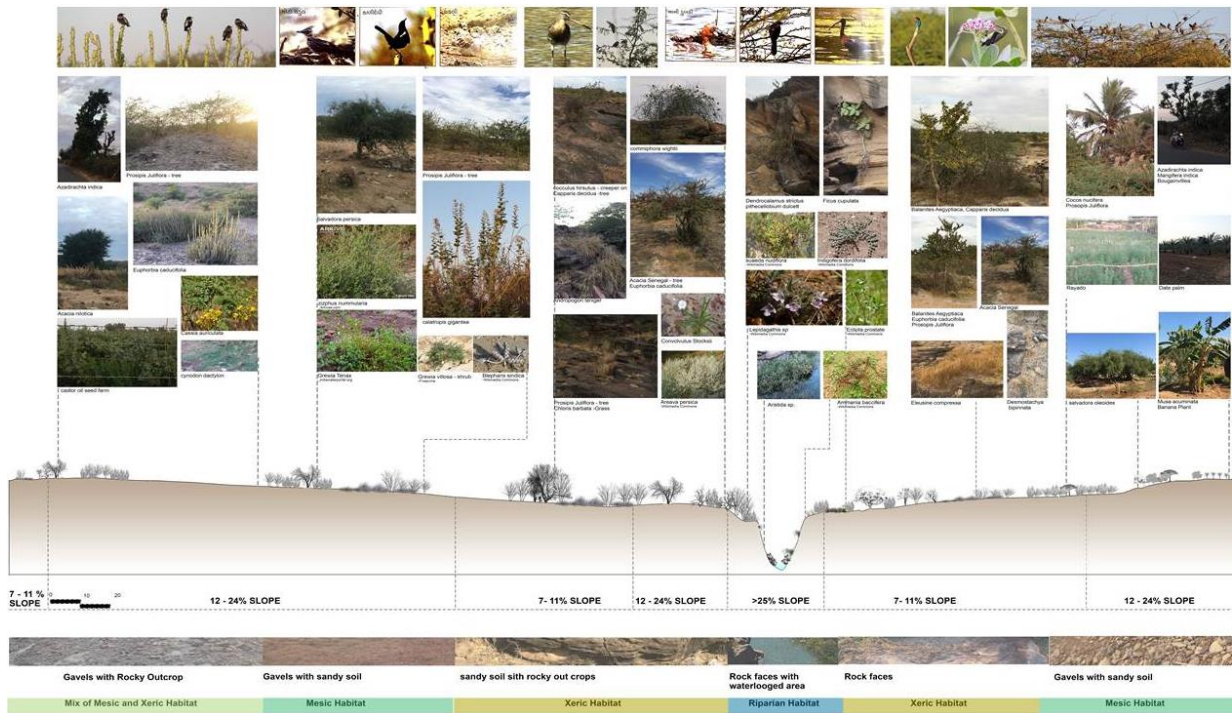
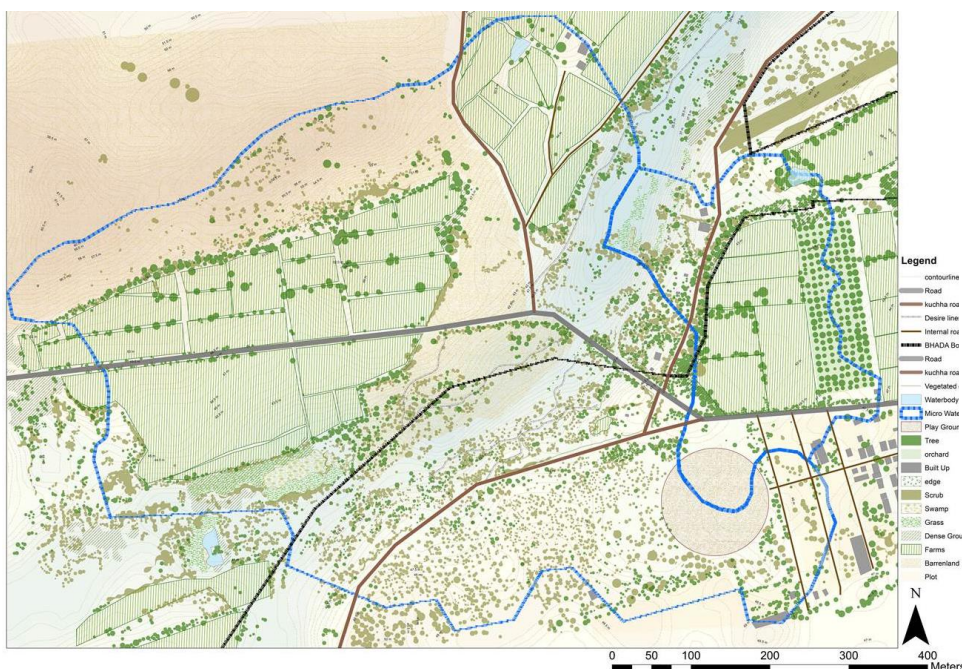


Figure 13
Habitat
Distribution

Source: Author.



Map 11
Vegetation Base
map

Source: Author

CHAPTER 4: SITE DOCUMENTATION

road as it is much more manipulated by human. Species list and habitat understanding is shown in image. The mapping of the species is based on site visits. road as it is much more manipulated by human. Species list and habitat understanding is shown in image. The mapping of the species is based on site visits.

ECOLOGY							
species type	species name	local name	Favorable slopes	shade loving/sun Stoving	favorable condition	Habitat	Benefits
Tree	Salvadora persica	Khari Jaal	rocky depression	sun loving	sandy , loamysols, Saline soil	mesic	90 mteres from mean sea level
Tree	salvadora oleoides	Mithi Jaal	rocky depression	sun loving	sandy , loamysols, Saline soil	mesic	Fruits Attract birds
Tree	Capparis decidua	Kerad	Well drains slopes	sun loving	Loose and gravelly soils	mesic	
shrub	Cassia auriculata	Aavad	sudden slope (near Road)	sun loving	dry sandy soil	mesic	
creeper	coccilus hirsutus	vevadi	earthen bunding	sun loving	Hedge grow, sandy soil	mesic	invasive creeper
tree	Maelytenus emarginata	vikado	Plains, well drain slope	sun loving	Open field	mesic	medicinal plant
shrub	Pontotropis spirais	goti yali	Plains, well drain slope	sun loving	Open field	mesic	use as field fences or bush
Tree	zizphus nummularia	bordi	Plains, well drain slope	sun loving	Sandy soil	mesic	best fodder
Herbs	Abutilon indicum	khapat	plains	sun loving	waste land of field	mesic	
Grassess	Chloris barbata	ruchdadha	Plains	sun loving	sandy soil	mesic	
Tree	Acacia Nilotica	bavad	Plains	sun loving	sandy soil	Xeric	
Tree	Prosopis Juliflora	Ganda Bavad	Plains to moderate slopes	adaptable	sandy , loamysols, Saline soil	mesic	invasive
Tree	Grewia Tenax	jagani	Plains to moderate slopes	sun loving	sandy,rocky soils.	mesic - Xeric edge	best fodder for sheeps and goat, edible fruits.
shrub	calatropis gigantea	aakado	Plains to moderate slopes	sun loving	sandy , loamy soils, Saline soil	mesic - Xeric edge	attract many birds and honey bee
shrub	Grewia villosa	Luska	Plains to moderate slopes	sun loving	sandy, hilly area	mesic - Xeric edge	
Tree	pithecolobium dulce	Goras ambli	along drainage lines	sun loving	sandy rocky soils.	mesic - Riparian edge	
Herb	areava persica	bu	along drainage lines	sun loving	sandy soils	riparian	soil binder in desert reclamation.
shrub	cadaba fruticosa	Kalo Pinjolo	along drainage lines	Shade	dry riverbed	riparian	Fruits Attract birds
Tree	cordia gharaif, Cordia sinensis Lam	Gudi	along drainage lines	shade loving	sandy, rocky soils.	riparian	Fruits Attract birds
shrub	Ipomea speciose	lotiyar	along drainage lines	sun loving	water edge, Moist soil	riparian	
shrub	suaeda nudiflora	lano	pond, river edge	sun loving	moist, sally soil	riparian	
Bamboo	Dendrocalamus strictus		Hill Sides (Steep slope)	Shade	Stony, Gravelly soil	riparian	Less in number
Herb	andropogonis paniculata		Hill Sides (Steep slope)	Shade	Stony, Gravelly soil	riparian	
tree	Ficus cupulata	Pakhree	difficult or steep slope	Shade, moisture	rocky depression, joints, fractures	riparian	Less in number
Herbs (glabrous)	Ammania baccofera	jal agiao	pond, river edge	shade	marshy sedge	riparian	
Herbs	eclipta prostate	jal bhangero	pond, river edge	shade	marshy sedge	riparian	IUCN red list
Herbs	Lepidagathis sp	harancharo	plain to moderate slope	adaptable	Dry sandy area to moist soil	riparian	
Grassess	Aristida so.	jaoadu	varies	adaptable	Moist soil	riparian	
Tree	Acacia Leucophylla	Haramo Bavad	Hilly slopes	sun loving	Loose and gravelly soils	Xeric	best fodder
Tree	Acacia Senegal	Gorad	Well drains slopes	sun loving	Rocky hills, dry sandy soil	Xeric	Nitrogen fixation
Tree	Balanites Aegyptiaca	Igoriyo	Well drains slopes	sun loving	Rocky hills, dry sandy soil	Xeric	
Tree	commiphora wightii	gugad	hilly, Rock joints, Depression	sun loving	Rocky hills, dry, gravelly soil	Xeric	best fodder, medicinal plant, IUCN Red list.
shrub	Euphorbia caducifolia	thor	Hilly slopes	sun loving	sandy, hilly area	Xeric	
shrub	Sarcostema acidum	sandhewal	well drain slopes	sun loving	rocky area	Xeric	Fruits Attract birds
Herbs	Biepharis sindica	kandher Gokharu	Plains, well drain slope	sun loving	gravelly soil	Xeric	
Herbs	Convolvulus Stocksii		hilly, Rock joints, Depression	sun loving	Mostly restricted to loamy and gravelly soils with moderate soil depth	Xeric	Threatened Rare, IUCN red list
Herbs	Fagonia Schweinfurthii	javasee	Plains, well drain slope	sun loving	gravelly and sandy soil	Xeric	
Herbs	Indigofera cordifolia	gadi	Rocky Sides (Steep slope)	sun loving	Stony area with Gravelly soil	Xeric	
Herbs	Periploca aphylla	ratikhep	Rocky Sides (Steep slope)	sun loving	Rocky outcrop	Xeric	
Herbs	Polygala eriopora	pershan	Rocky Sides (Steep slope)	sun loving	sandy soils	mesic	
Herbs	Vernonia cinerea	tadadio	hilly, Rock joints, Depression	sun loving	dry sandy soils	Xeric	
Grassess	Desmostachya bipinnata	dabhadu	varies	sun loving	dry sandy soils	Xeric	
Grassess	Eieusine compressa	madhanu	varies	sun loving	dry sandy soils to rocky outcrops, gravelly soil most favorable	Xeric	forage for sheep and goat grazing
Grassess	Cenchrus ciliaris	dhaman	Plains	sun loving	dry sandy soils	Xeric	
Grassess	Andropogon laniger	kuyadidha	varies	sun loving	dry sandy soils and well drained moist soil	Xeric and mesic	
Herbs	iphiona aucheri		hilly, Rock joints, Depression	sun loving	dry sandy soils	Xeric	
Farm and orchards							
Tree	Date Palm	khajuri	Plains	sun loving	orchards	mesic	
Tree	Azadirachia indica	limado	Plains	sun loving	open fields	mesic	
Tree	Bougainvillea		Plains	sun loving	open fields	mesic	
Tree	Cocos nucifera	naryeli	Plains	sun loving	sandy soil	mesic	
Tree	Acacia auriculiformis		Plains	sun loving	sandy soil	mesic	
Tree	Mangifera indica	ambo	Plains	sun loving	well drain, sandy loamy soil, orchard	mesic	

Figure 14 Species Record

Source: Author

Understanding of Listed Habitat.

Xeric Habitat: “characterized by, relating to or requiring only a small amount of moisture” (Merriam-Webste, 2018).

Mesic Habitat: “Mesic Applied to an environment that is neither extremely wet (hydic) nor extremely dry (xeric)” (Ecology, 2018).

Hydic/ riparian Habitat: “Riparian Habitat is land and vegetation near streams, rivers, and wetlands. Healthy riparian areas generally include trees, shrubs, and groundcovers that provide shade and stabilize banks” (Watersheds).

CHAPTER 5: SITE ANALYSIS

Site analysis is done majorly through first hand data collected through series of site visit. Process of analysis is done to know the edge and limit of the Geo park in entire watershed area. Overlaying process has been use to define the boundary of the geo park in watershed. Series analysis is been carried out to reach the planning strategy and programme for the Geo park design.

1. Visual analysis
2. Ground analysis
3. Landscape appraisal

5.1 GEO PARK BOUNDARY

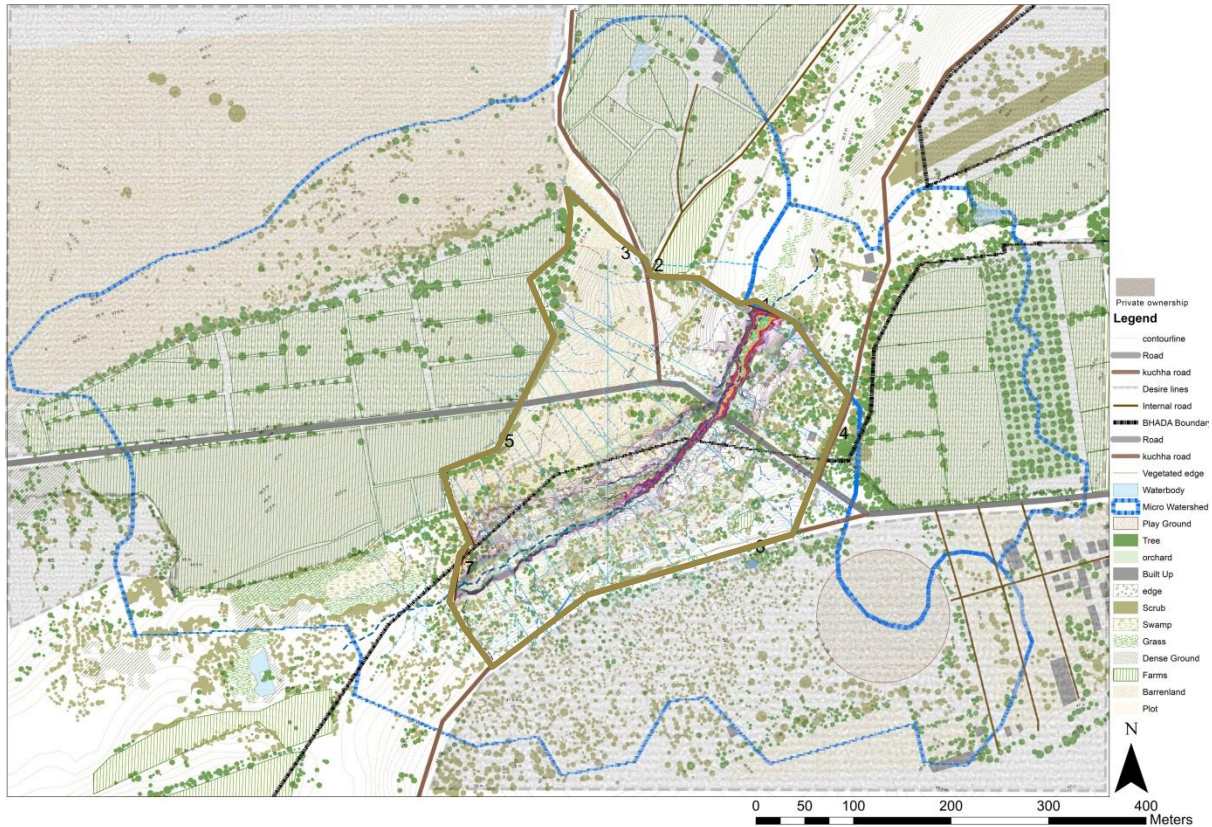
Geo park boundary is derived from the analysis of the three layers of the sites.

1. Natural streams and valley lines marking – streams are known be the landscape boundaries in all the landscape study. Here the valley that meet up the gorge downstream and upstream faults are taken as the reference for the park boundary.
2. Ownership of the land parcel – on both the sides of the terraces agriculture lands, residential plots are visible, the ownership of this land parcels belongs to individual and not the local authority. So this boundary is taken in to park boundary derivation.



Figure 15 Site images for Park boundary

Source: Author



Map 12 Park Boundary mapping on Base plan

Source: Author

5.2 Visual analysis

In order to carry out the visual analysis of the gorge landscape series of sectional and spatial understanding is needed. I have done detail aping of the gorge landform to do the sectional understanding of the site. the section are perceivable spatial planes to understand the space, relief, slopes in vertical plane. This understanding helped me in the deriving the kind of intervention that needed for different location.

5.2.1 Gorge Mapping:

Gorge mapping was done with the specialised survey equipment known as DGPS – digital global positioning system. This is the survey techniques which help to survey the difficult ground planes. The survey machine is connected global positioning system through portable router and Wi-Fi. It takes position of the ground at particular point. The connected interpreter shows the Height of the point from the mean sea level, longitude and latitude of the point. By help of this machine one can map the ground accurately. One can ensure the accuracy of the survey by taking more

numbers of the survey points. This mapping was the part of visual analysis. Through this real-time survey, I have confirmed many facts of the ground and try to use it in my design. This survey has produces points and these points are then interpolated to make contour map through the software name E-Survey. It took & days to survey the gorge landscape with the detail resolution of 1 meters.



Figure 16 Documentation

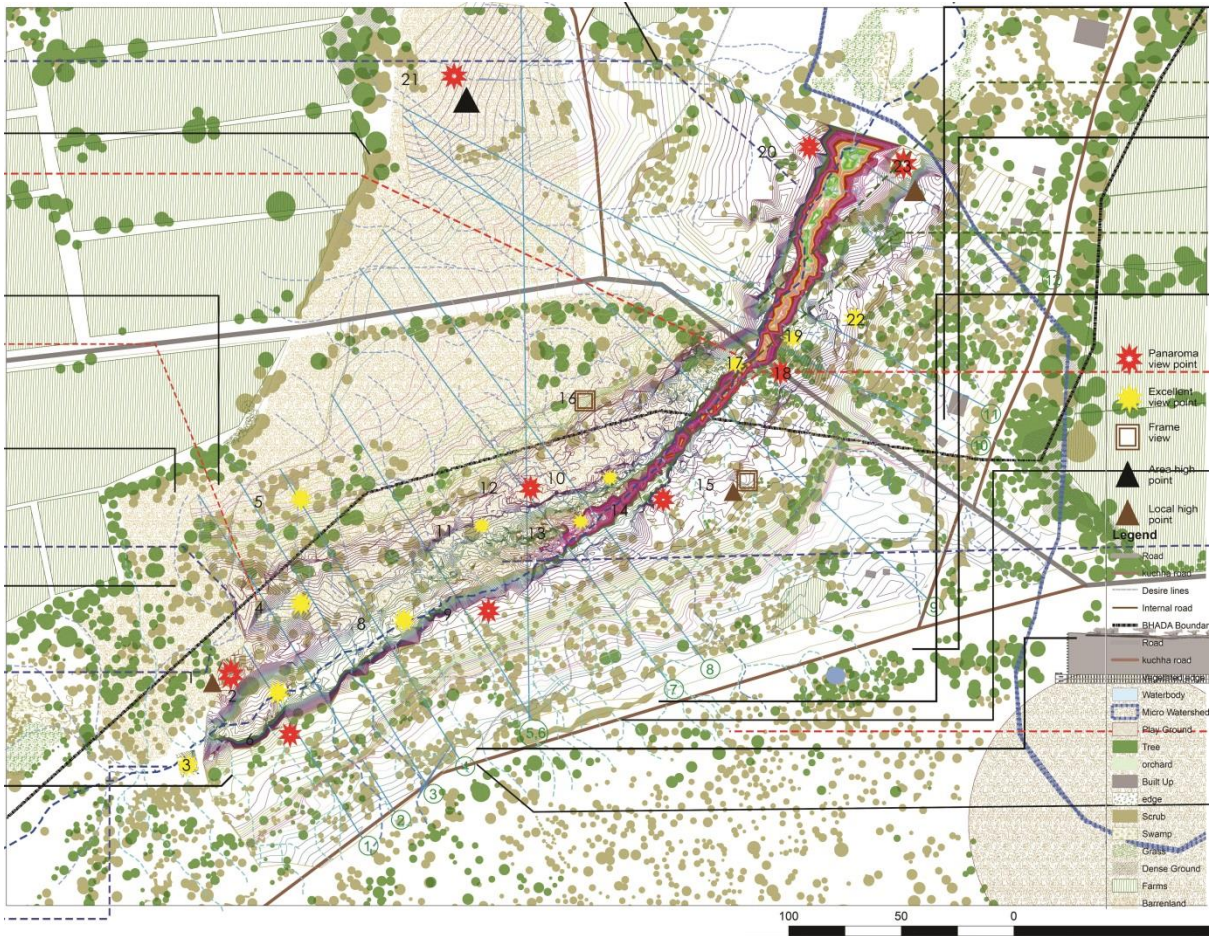
1. From the left – DGPS survey tools.
2. Survey of site using the DGPS tool – Photograph taken at gorge edge.
3. Photographic documentation of gorge

Source: Author

5.2.2 Viewpoints analysis

Visual analysis was done to Identify different view types of viewpoints in gorge landscape. Mainly there are two types of views – Panoramic view and excellent view in the landscape. All the view points are based on below listed selection criteria.

1. Visitors should be informative and reveal details about the landform from that particular point.
2. Local high points are one of the kinds of viewpoints.
3. Panoramic viewpoints, these viewpoints are possible on the higher elevation and ground where there is less or no eye vegetation. The analysis of viewpoints is the anchor points in the landscape, as they reveal the story of the landform. These viewpoints are considered as the paused points and observation points while designing park.



Map 13 View Point mapping

Source: Author



Figure 20 Fault Line Sketch



Figure 20 Escarpment View



Figure 20 Downthrown Zone

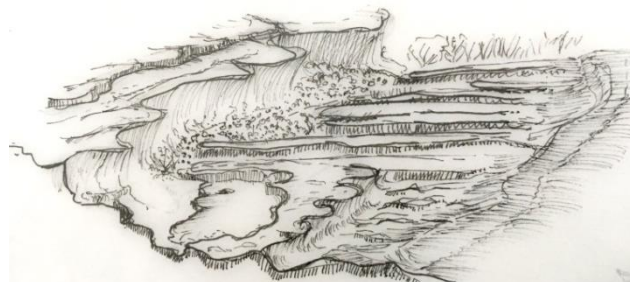


Figure 20 Conversion Zone

Map shows different viewpoints in the gorge landscape. The contour mapping for the analysis is based on the real time survey and perceived spatial value of the viewpoints area is explored in next images.

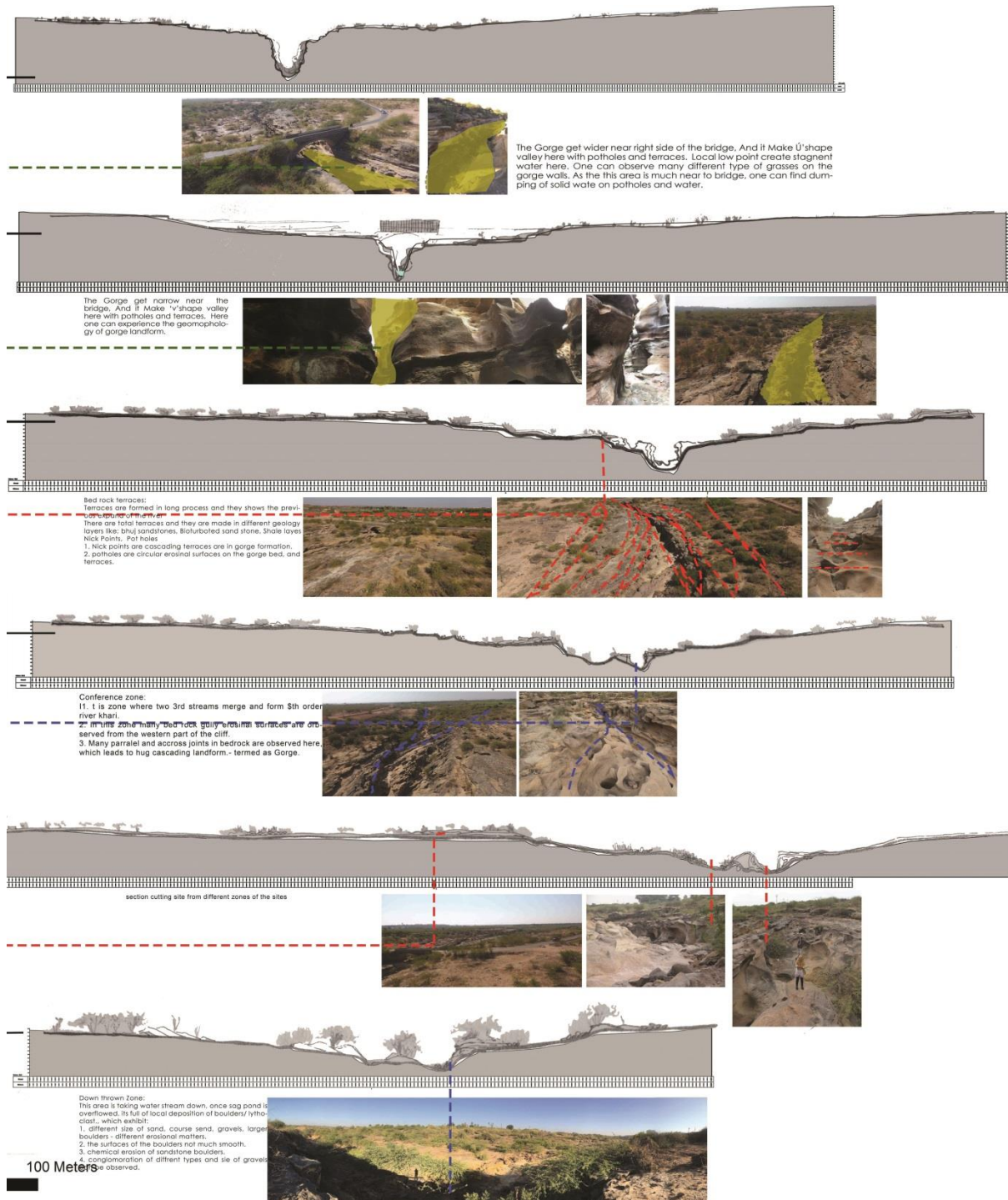
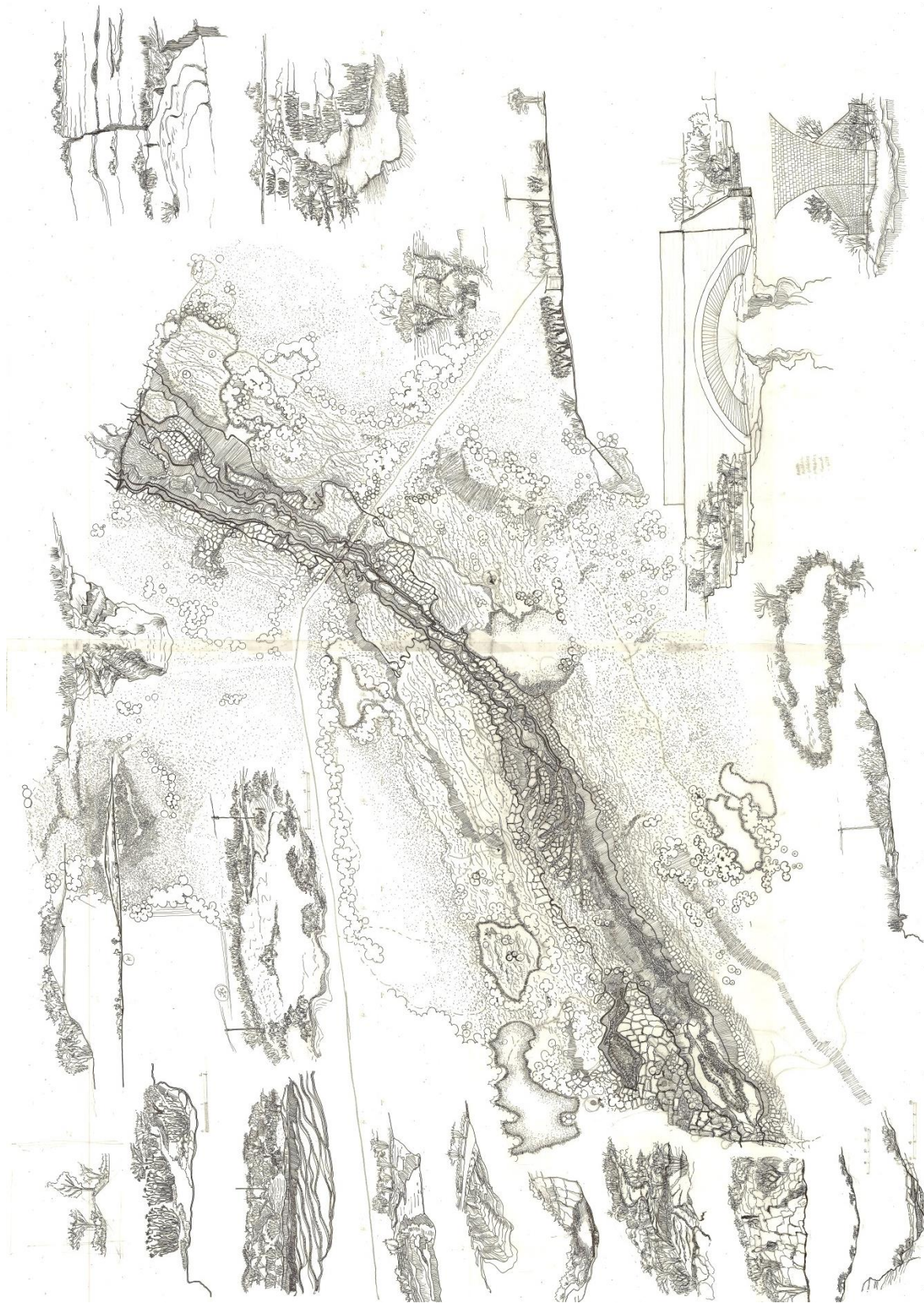


Figure 21 Sectional Understanding of Gorge

Source: author

In this image different cross section of gorge landscape for understanding visual and spatial character of the site.

5.2.3 Ground texture analysis



Map 14 Texture Map of Ground

Source: author

Texture of the ground makes this gorge area unique and worth explore. There are texture available on the site varies from rock faces, boulders, gravels to sandy soil. The texture of the ground helped me in the decision of trail making and detailing of the trail material. Also texture map is suitable for deriving the preservation area and recreational areas of the site. The major program building and strategic location of the program activity is purely based on the ground texture for judging the suitability. Example of it – sandy soil area is most suitable for the recreational area whereas the rock faces and boulders from where one can observe the gorge and terraces is best location for educational trail.

5.3 Landscape appraisal

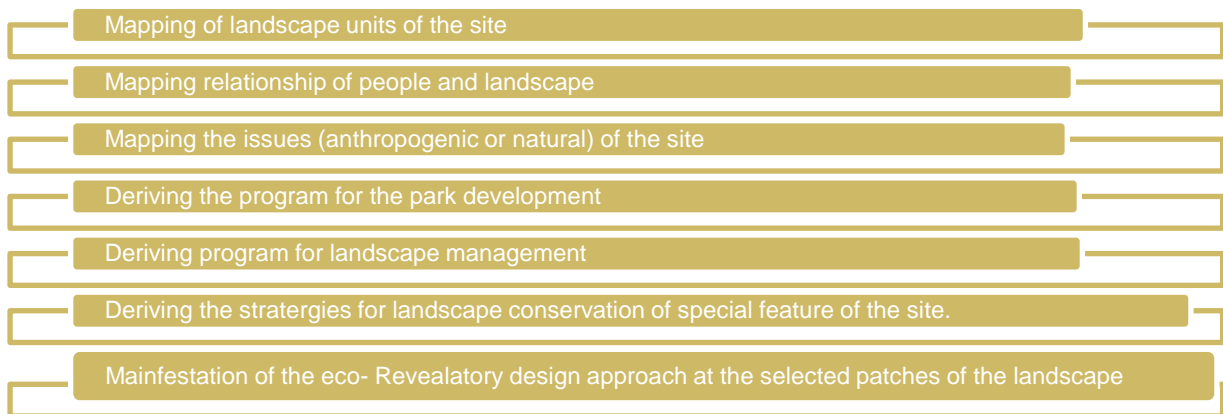


Figure 22 Landscape Appraisal Process

Source: Author

Landscape appraisal is mechanism which will provide criteria for decision making process. Landscape appraisal gives answers like whether the landscape required to be protect and conserve or it required to be developed and win what direction development need to be done. What are the natural features of the locality which need ameliorated to endure and enhance natural systems and its aesthetic quality. Landscape appraisal will also help in determine the type of intervention example - appropriate location, shape and form of development. I have used this mechanism to determine the program requirement for the Khari River Geo-park. *“In Britain landscape appraisals have largely been developed in countryside contexts and their application to the design of urban areas or the control of urban development has been very limited”* (Matthew Carmona). As selected gorge is also located on urban

fringe area and not in the core urban area it is most likely to follow this method to achieve desired result of deriving program for park.

5.3.1 Mapping of Landscape Unit

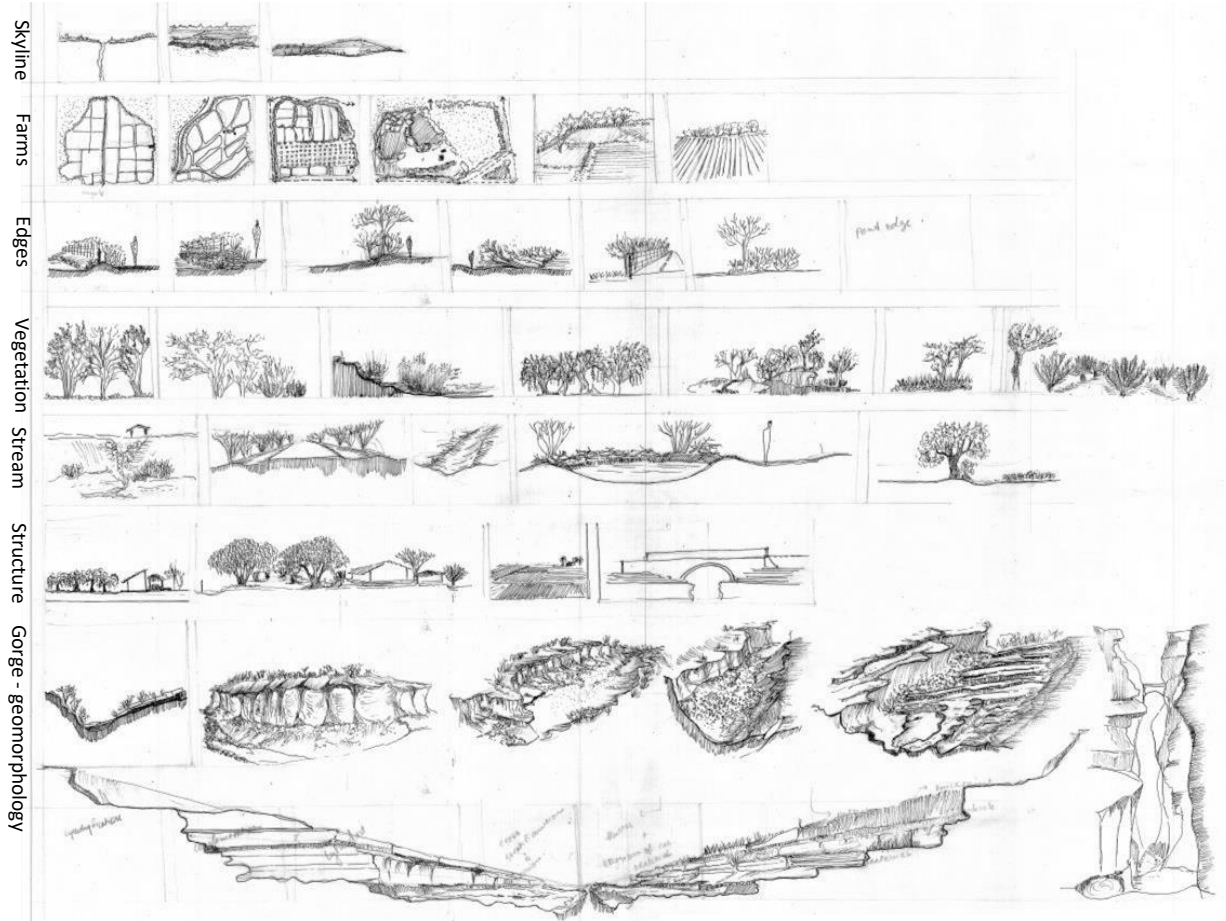


Figure 23 Landscape units mapping

5.3.2 Mapping Association:

After landscape unit mapping the association of the local and visitors with gorge landscape is mapped to understand the potential and current use of the landscape and make the design decision robust and profound for current and future scenario. There are many activities happen on the site – recreation, bird watching, enjoying natural beauty; star gazing, also part of it serves as pasture land.

5.3.3 Mapping Disturbances:

There are many issues site is facing due to lack awareness and ignorance of local and visitors. Like- extraction of soil and rock from the River terraces, cutting of trees, extracting of ground water, site is also house for shady activity, dumping of solid waste from hospitals and hospitality industry is also huge nuisance to landscape. some part of the site is very much accessible by large vehicles where local dumb construction waste. Other than anthropogenic and local scale disturbances site also

CHAPTER 6: DESIGN

For Design chapter is divided into program, strategies and design development chapters

6.1 Program

Program for Geo-park is derived from the landscape appraisal and analysis.

Agriculture		<ol style="list-style-type: none"> 1. Orchard designing – picnic area 2. Mesic Tree planting for recreation development in buffer area
Edge		<ol style="list-style-type: none"> 3. Edge plantation 4. Plantation for shade and visual barrier and developing buffer
Reforestation		<ol style="list-style-type: none"> 5. Landscape restoration 6. Native plant Nursery for park and local people.
Stream strengthening		<ol style="list-style-type: none"> 7. Erosion control. 8. Plantation along streams
Educational program		<ol style="list-style-type: none"> 9. Educational trails 10. Outdoor classroom 11. Recreational Trail and view points
<p>Park Facilities and amenities – Orientation area, Café, information and signage, parking, Rest rooms,</p>		

Figure 24 Program

Source: Author

6.2 Design strategies:

Laying out the program for the proposal was the major part of the design. After the careful understanding the site, a SWOT analysis was done to evaluate best possible location for the listed program. Design strategies were made for different functional aspect of the design program. There are two levels of the intervention given for the

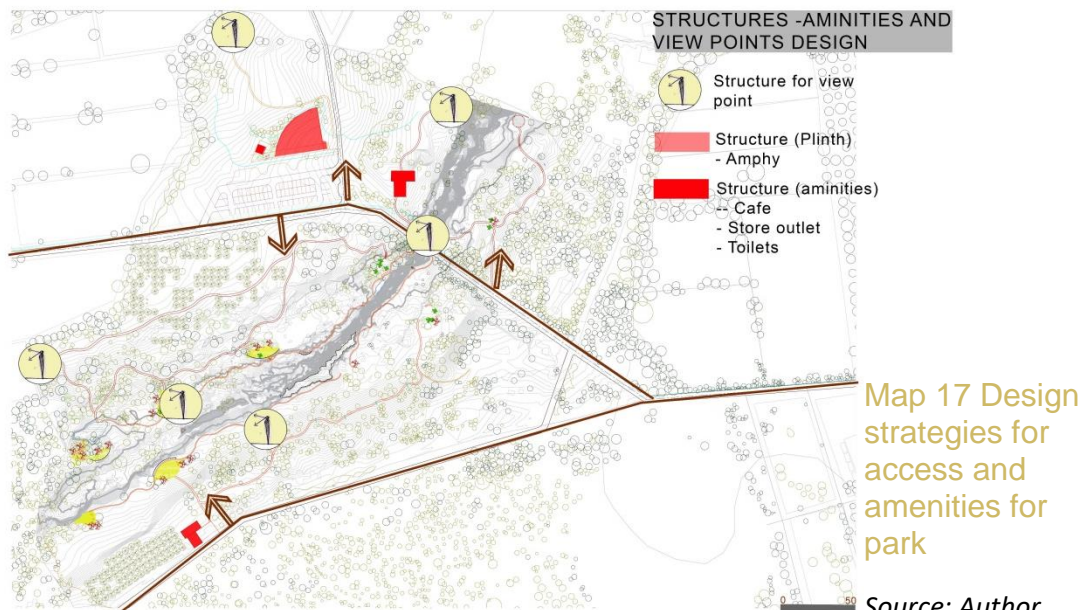
landscape. Guidelines were given at watershed level for the landscape management. Whereas detailed design proposal is given for Geo Park.

zones	Terrace :1	Terrace :2-3	Terrace : 4-5-6	Terrace :2-3	Terrace :1
Strength	<ol style="list-style-type: none"> Terrace 1 is most accessible zone of the site. The slopes are workable and moderate in in this zone. Many different type local vegetation can be observed on this terrace. 	<ol style="list-style-type: none"> Terrace 2, 3 is Highly eroded and exhibit unique pattern of gully erosion, plucking and fluting on the surfaces, many area has trace fossils on the surface. The moderately accessible terrace with rewarding view. This zone has very less soil depth the local desert plants which can grow even on the bed rock can be seen here. 	<ol style="list-style-type: none"> Terrace 4-6 are highly pitted and have numerous pot-holes, cavitation, caves, niches, cliffs, escarpments, high wall joints and fault in it. The unique landform of gorge is always in the mutual shadow and it is house of biodiversity and fauna like - bee, bats. It gives rewarding view after difficult hiking. 	<ol style="list-style-type: none"> Terrace 2, 3 is covered with vegetation. The moderately accessible terrace with rewarding view. Many trails can be seen here as it is used by Maldharis community for pasture. 	<ol style="list-style-type: none"> Terrace 1 is most accessible zone of the site. The slopes are workable and moderate in in this zone. Many different type local vegetation can be observed on this terrace. Terraces is much occupied by the maldhari vas and boundary is very well defensed by the local.
Weakness	<ol style="list-style-type: none"> As terrace :1 is shared boundary with road and adjoining farms, many people use this area for dumping waste, extraction of soil and local stone from this zone of the site. This zone is highly got invade by Prosipis juliflora, The native vegetation of grasses and other understory is mostly absent on this terrace. 	<ol style="list-style-type: none"> Soil Quality and depth is very poor on this terraces, Planting and other intervention required sensitivity. Much of Prosipis juliflora can also be observed here. As it is highly eroded it is difficult area for intervention and management, due to difficult sloes and loss of visual connection with upper terraces. 	<ol style="list-style-type: none"> On Terraces 4-6 where bridge is crossing over this makes it vulnerable to waste dumping by negligence people. It has the local low point and it has water and moisture level high when rest of the river don't have the water, and all the solid and other water get stagnant there. The slope are not easily accessible. 	<ol style="list-style-type: none"> Soil Quality and depth is Good on this terraces, Planting and other intervention required sensitivity. Much of Prosipis juliflora can also be observed here. It is approachable from the adjoin houses of the Maldharis, they cut the vegetation woody plants from this terrace for domestic use, in this they cut very rare plants also. 	<ol style="list-style-type: none"> Contour flattening for future development is observed here on the site. Extracting ground water, soil and local stone is observed here on the terrace. It share boundary the connecting road on one end and it makes it most accessible edge of the site. Cutting and clearing ground can be seen here.
Opportunity	<ol style="list-style-type: none"> As The soil depth is good on this zone, plantation can be done to achieve the Goal of ecological restoration. The slopes are workable on this zone of the site, it is create opportunity to develop it as the more of outdoor recreational zone with less disturbance to the site, the development will include trail with less difficulty level, bicycle trail, view platform and places for group interactions. 	<ol style="list-style-type: none"> This terraces can be the places for harder hiking trails and educational ground students. As local threaten species are found on this bed rock plane,, It can be conservation ground for them. As the terraces are visual more connected to lower terrace 4-6, it creates curiosity and stimulate the visitors to know about gorge. 	<ol style="list-style-type: none"> As it showcases the evolution of the landscape of Kutch from the escarpment wall it exhibit sand stone of Bhuj formation, it contains high visual, stimulating and education value. It is the most unique place of interest of the site. As it is difficult to access it drain out the possibility of footfall. 	<ol style="list-style-type: none"> This terraces can be the places for harder hiking trails and educational ground students. As local threaten species are found on this bed rock plane,, It can be conservation ground for them. As the terraces are visual more connected to lower terrace 4-6, it creates curiosity and stimulate the visitors to know about gorge. 	<ol style="list-style-type: none"> As The soil depth is good on this zone, plantation can be done to achieve the Goal of ecological restoration. The slopes are workable on this zone of the site, it is create opportunity to develop it as the more of outdoor recreational zone. It required intervention for improving edge condition, soil quality and moisture level, it also required intervention for improving visual quality of the site.
Threat	<ol style="list-style-type: none"> As this zone highly Accessible from the connecting road, it is more vulnerable to Face issue regarding Future urban growth and traffic. Edge with road can create disturbance for local flora and fauna. 	<ol style="list-style-type: none"> The terraces required regulation during high footfall as it exhibit trace fossils and it is the suitable habitat rare plants species. Required sensitive details for safety. 	<ol style="list-style-type: none"> Without regulation gorge can get damage with high footfall. Many reptiles and local fauna can harm the visitor and also footfall can damage their habitat. 	<ol style="list-style-type: none"> The terraces required regulation during high footfall as it exhibit trace fossils and it is the suitable habitat rare plants species. Regulation and guideline is require to manage the woody plant harvesting by local Maldhari. Required sensitive details for safety measures. 	<ol style="list-style-type: none"> As this zone highly Accessible from the connecting road, it is more vulnerable to Face issue regarding Future urban growth and traffic. Edge with road can create disturbance for local flora and fauna. Regulation and guidelines required for controlling the extraction of water, soil and local stone from this area of the site.

Figure 25 SWOT analysis

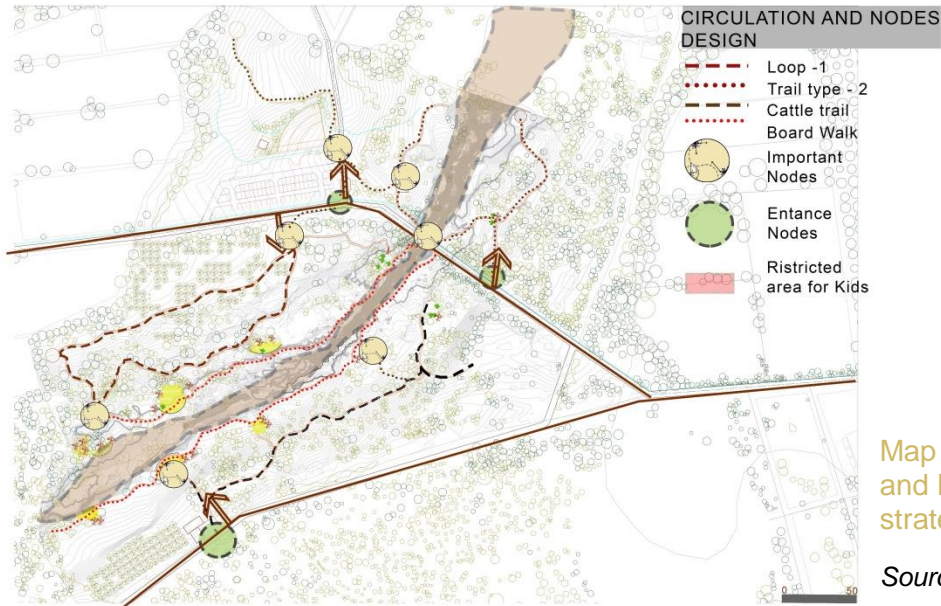
Source: author

6.2.1 Strategy for access to Geo- Park



There are two existing roads that passes from the site and which will govern the site development. All the facility regarding entrance and other park amenities are located near road.

6.2.2 Strategy for circulation design for Geo- Park



Map 18 Circulation and Pause point strategy map

Source: Author

Laying out the circulation was the toughest part of the design. Connecting all the viewpoints and creating trail with the conscious effort of drawing out the lines on landscape. Having minimum intervention on the landscape and minimum cut fill process with comfortable gradient were the basic concerns while designing trails. There are three types of trail as per their materials, use and gradient. Trail type -1 is made of the rammed earth with most comfortable and easy walk. Where trail type- 2 is of local stone with many pause point along the terrace 1. The trail type 3 is board walk on the most pitted ground of bed rock. The elevated board walk trail is proposed for not disturbing drainage pattern during rainy season. Trail type 3 has out door class room and observation points. Shape and form of the material are selected in way that it reveals the drama of the ground.

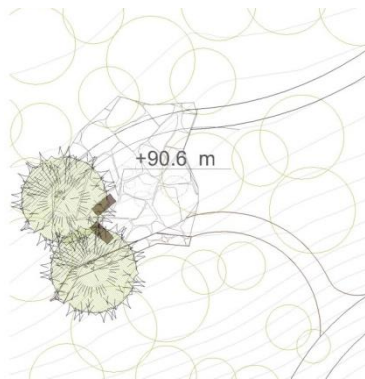


Figure 27 Pause point in existing Enclosures

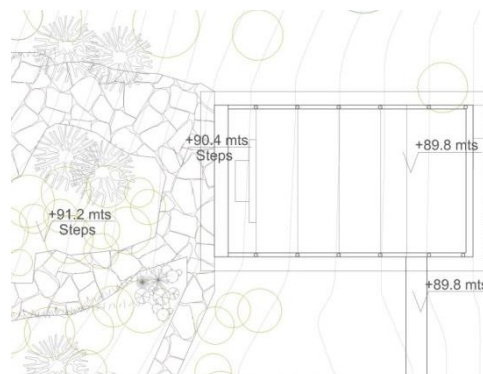
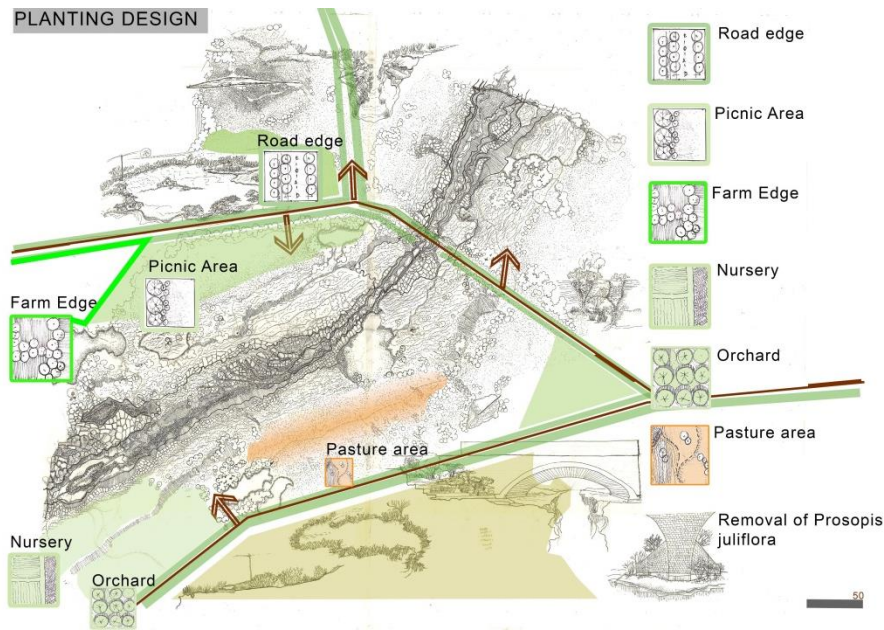


Figure 26 designing program along the contours

6.2.3 Strategy for Planting in Geo- Park



Map 19 Planting Strategies

Source: author

Planting on the rock outcrops and sandy soil with poor depth is most challenging aspect of the project. In order to solve different strategic and program function a strategy is device. Building a toe wall which locally known as “paad” along the stream will stop the water and allow vegetation to come up by its natural way. This process will take time to be sustainable at its own but it will result in good soil and Landover condition. Other than that various local plants are selected for reforestation, edge defining and orchard and pasture areas which are described in the map. Selection of plant is based on the Soil type, climate and functions.

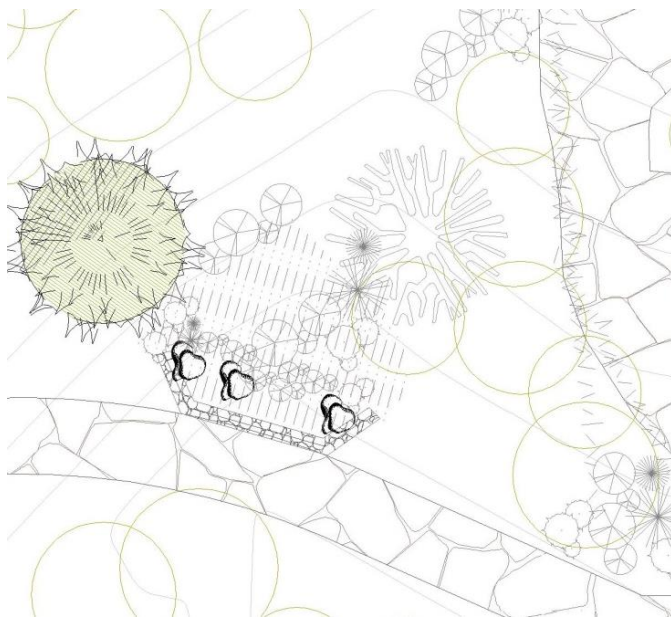


Figure 29 Paad Construction

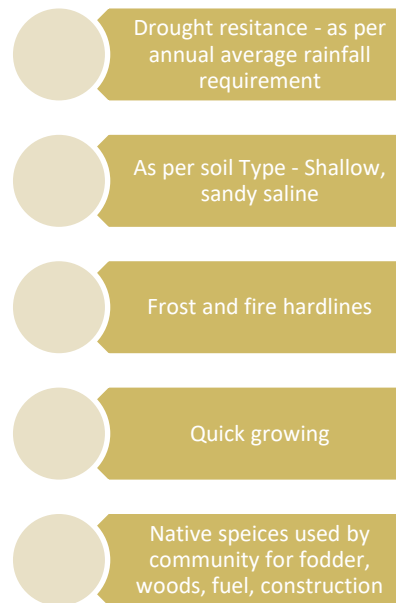


Figure 28 plant selection criteria

6.2.4 Design Development:

For design Development, outdoor recreational area standards are considerate. The standards are from the book written by Simon bell (Bell, 2005).

There are few concerns which followed like, use of local material to build the amenities,, use of site material to lower the impact on landscape and also make a visual connection in details. Informal seating is derived from the Boulders only.

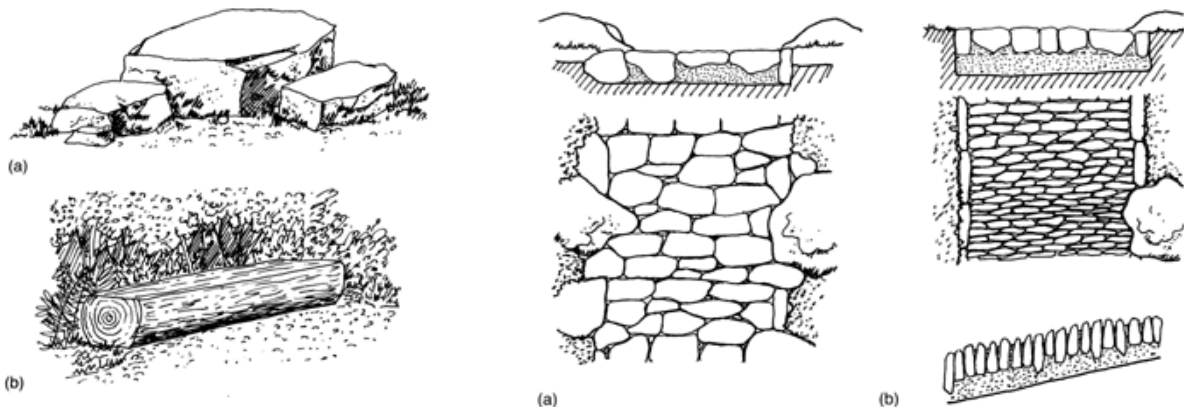


Figure 30 -Trail Details

Figure 31 a - Rock arranged as Picnic table and seat;

b - A bench Design out of Rock

Source: Book Design for outdoor recreation.

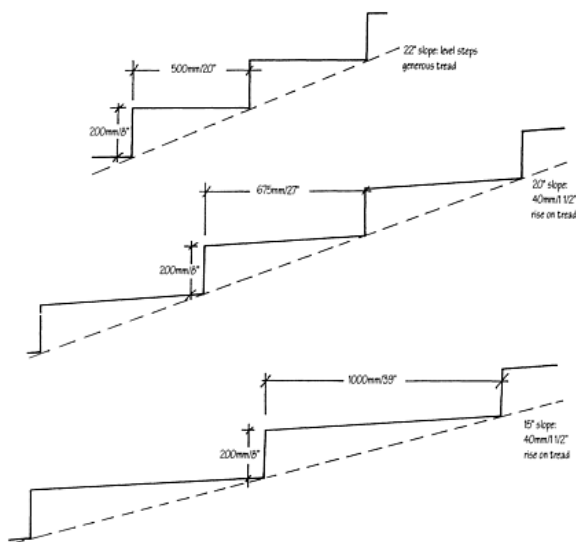


Figure 33 Standards Followed for outdoor steps.



Figure 32 Vertical steps for Cliff climbing section

CHAPTER 7.0 CONCLUSION

The purpose of this thesis is to create educational, experiential and recreational spaces for connecting the body to the landscape. Use of landscape processes, such as the geomorphology, to set a narrative that Geo-park will offer to Visor for exploration and experience through open or a guided, narrative. It is my anticipation that designed experience of Geo Park, will built recognition of Gorge among users and visitors even through the recreational program detailing. Design will nurture a connection between people and the landscape. Moreover, in revealing the drama of the ground and landscape, the design could affect future decisions of man about the landscape and its value.

Note: Design development process and design manifestation can be explore in design sheets from next page.

COMMENTS

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