# Sustainable Architecture

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## Introduction

The field of architecture has been the crown jewel of human achievements since prehistoric times. From primitive cave dwellings to the towering Burj Khalifa – immense heights have been literally achieved in this discipline. And yet, over the passage of time, we are only furthering away from what can be termed sustainable architecture. Considering the global problems thrust upon us, it has become mandatory to have a nuanced dialogue around sustainability.

As a society, we are all bombarded with the term 'sustainability' to an extent that it is white noise to our ears now. When we hear 'sustainability' we no longer know what exactly to expect because anything and everything (whether sustainable or not) is portrayed and sold as sustainable. Before we proceed any further, it is important to define sustainability so that we can draw some references for further evaluation.

We can simply break the term "sustainability" into two parts which mean "the ability to sustain". The ability of the planet to sustain all species and ecologies with its finite resources along with the species and ecosystems reciprocating the same towards the planet. This is a symbiotic relationship. This relation cannot be that of a master and servant but of mutually benefitting friends. However, man has treated nature as his servant and himself as his master.

## Pre-industrialized construction systems

For centuries, the common man lived in self-constructed dwellings made from materials freely available in nature. These structures stood the test of time, completed their lifecycles, and went back to being a part of nature with a bare minimum or zero waste generation. This cyclic system of construction did no damage to the environment. Biodiverse natural materials like mud, reeds, thatch, adobe bricks, bamboo, cow dung, stones, wood, lime, and many others were the construction materials. For ease of construction, these were locally sourced.

Naturally, all the materials grown or located within a region are acclimatized to the region and therefore respond well to the climate in which they grow. With a natural change in geography and geology, the available construction material changes. Biodiverse consumption of resources never caused a single specie to experience consumption pressure (any examples of monoculture plantations today can be taken up to examine and understand this point).1 This helped people within a region value and conserve all biodiversity equally as they depended on all of it equally. Hence, every region had developed its unique vernacular architecture.

Another important aspect of pre-industrialization was the acceptance of the impermanent and transitory nature of life. It was an accepted fact that man's dwelling would be in constant need of regular maintenance. Maintaining a dwelling was seen as a part of living and growing along with it. The idea of permanency was alien as every system involved natural circular processes and materials which were bound to go through repairs and deterioration. In many communities, the annual activity of building and home maintenance was taken up as a celebration. Such trends are still practiced in remote villages of India. To this day, tribal villages participate in sweat equity to plaster or make community structures. Thus, a socially inclusive interconnected system existed earlier and continues to do so.

Natural construction materials used did not involve any energy apart from the muscle power or animal power that went into processing these materials to be fit for construction. The construction was based either on the need of the

individual or that of the community. It was never a structure built to complete numeric targets or to create false demands. The most sensible part was the foresighted pre-planning before a structure was built. For example, trees planted by the forefathers of a family were cut to make a house roof. Parallelly, trees were replanted for future generations.

The scale of these structures was only as big as the environment could support and as needed by the household. The cycles of regrowth of renewable materials like wood matched with the rate of consumption. The demand always matched the supply or the demand was lesser than the supply. Yet, this was a conscious effort made with a sense of symbiosis and reciprocation.

## The scenario post industrialization

Each cause has an effect that comes about later in the timeline. The global crisis that we are in today must have a cause somewhere in the past. A closer look at the past two centuries can help us understand what affected us. Until the industrial revolution, the production of goods was in line with the natural limitations imposed upon resource consumption and waste generation. Resources under the earth's surface were difficult to access manually on a large scale. With the manufacture of heavy industrial machinery, the slow-moving manual processes fast-tracked. To increase the number of machines, metals and various other ores were mined at an accelerated pace.

The growth of heavy industrial machinery brought newer building materials like cast iron, steel, and glass with which architects and engineers rearranged the concept of function, size, and form. This also led to time-saving building technologies that needed much less maintenance. They also meant lesser man power with higher specialized skills. Faster modes of transport aided in transporting construction materials to larger distances.

In the span of two centuries many such 'industrial construction products' have entered the market and destroyed the eco-friendly material palette that existed regionally and practiced locally. This was not the only damage made. The local

skillset, arts and crafts which were identities of many regions, collapsed over time as people inclined towards the time saving, cheap and fancy new material in the market.

On one hand, ambitions grew at a rapid pace, whereas on the other, we saw the rise of urban cities and towns, concentration of wealth in the hands of a few, immigration of people from villages to the cities, added carbon emissions due to the transport, heavy usage of fossil fuels. This further led to the development of a new class of labour force and factory workers, the concentration of job opportunities in factory zones, poor working conditions, etc. The environmentally hazardous waste that is generated from these industries pollutes the soil, water, and air. The global boon then has become one of the contributors to the global crisis we are in today. The sensitivity and the wisdom of vernacular architecture are replaced by blind growth and unprecedented development without questioning the scale of this boom and the lack of sustainable development.

With the increase in carbon emissions, disruptions in biophysical systems and depletion of renewable resources, the ongoing climate crisis has placed us right on the brink of decline. This crisis has only been aggravated by the prevalence of industrial materials in construction. As the ecological footprint increases in relation to the distance the materials travel to reach a construction site, the vast use of industrial materials contributes significantly to pollute the planet. According to the United Nations report published in 2019, the construction industry, with its operational emissions, accounted for 38% of the total global energy-related $CO^2$ emissions.[2]

## Sustainable architecture

Sustainable architecture is nothing that a lay person cannot understand. In fact, it is so logical and simple that even a child can understand it. It is best to state pointers with examples so that it becomes easier to put across certain points. It is important to note that 'sustainability' is not an absolute term. It is relative. This means any architecture can be called sustainable or not only in comparison to something else. There are many layers to sustainable architecture and to

understand the term more holistically, it is important that we cover multiple layers, if not all.

In India, environmental agendas and green buildings are often based on the precedents of developed countries. There are many fundamental changes required in development and planning national policies with regard to natural resources that would put India on a path of sustainable development. Moreover, it has to be formulated in a participatory manner, which involves most sections of the populace who depend on natural resources for life and livelihood reasons. All stake holders, not only humans, but also bio-diverse flora and fauna need absolute consideration when talking of participatory planning.

## Amateur's self-help guide to sustainable architecture

Every region and user is unique and the architecture can be tailor made only if this difference is acknowledged. There are various factors that can be taken into account to understand a tiny portion of what encompasses sustainable architecture.

The location of the building is quite critical. A rock bed or murrum bed could be a much better place to build in comparison to a black cotton soil farmland or a marshy land. This helps in reducing foundation costs and a simpler load bearing foundation can also be made instead of other heavier foundations like RCC, piles or raft.

Studying the site, its context, its landform and geography, watershed pattern if any, geology and old traditional structures around the site could be efficient cost-effective markers to understand so much more than what an empty site parcel can convey.

A lower ecological footprint equates to a sustainable construction. A farmhouse situated in a rural setting using local natural materials and skillset has a lower carbon footprint in comparison to an apartment made in a city like Mumbai

where materials have travelled larger distances to reach the construction site and specialized labour from elsewhere have constructed the apartment.

Scale of construction is another dimension we need to look into. A family of 4 members can be accommodated in a 500 square feet home or in a 20,000 square feet home. This decision depends on the family. However, if we look at the situation from a vantage point where the resources consumed in both the scenarios belong to a larger global community that we all are a part of, the redundancy of the 20,000 square feet house becomes clearer.

Using naturally available materials that are closer to the site of construction is beneficial directly as in most places in India, there are traditional knowledge banks with old masons who might have worked on a certain skill in their early days. The second advantage of doing so is that the transport cost is lesser. The hidden advantage is the low environmental cost. The third and biggest benefit is the creation of a healthy liveable space.

A correctly designed climate-responsive structure for a given location can be much more suitable to create a healthy human comfort level than a structure that is either incorrectly designed or not designed at all. This includes taking into account the basics of temperature, humidity, and rains. There are many more aspects that a professional can delve deeper into, but for a lay person, knowing this basic can help immensely. This can help design the overhangs of a building along with placement and size of windows.

The choice of material and structural design decides not only the life of a structure but also the aesthetics and health of people living within. A structure with lesser spans could employ materials like wooden beams or smaller RCC beams instead of steel sections. A load bearing structure could be used instead of a framed structure wherever possible after analysing the need of the said structure.

Orientation of structure on site plays a very important role. Not only the planning within the structure gets influenced by this factor, but also the sizes and placements of fenestrations.

Passive design in architecture should be the foremost principle applied to any building design. Passive design refers to simple techniques which can be incorporated into a structure to reduce its energy needs. Passive cooling of a structure means cooling a structure without the need of a mechanical air-conditioning system. This can be achieved by identifying the unnecessary thermal loads that the structure might encounter. Ample amount of daylighting and correct shading devices can reduce the usage of fans, ACs and lights during the day. In order to instil energy efficiency in construction, daylighting and natural ventilation should not be optional attributes but the basis of the entire design.

The finishes used inside the structure like synthetic, resinous materials or synthetic paints possess high levels of VOCs which are harmful to health. The choice of finishes depends upon the aesthetics and amount of maintenance one wishes. Lesser the maintenance, higher the level of detailing and finishes that need investment. This also means a higher ecological cost at times along with a higher financial budget. Eco-friendly options for tiling like terracotta tiles or terrazzo made from recycling waste marble could be opted. Most synthetic materials consume large amounts of energy and generate toxic waste by-products. Researching the material a bit can help open many options for eco-friendlier materials.

Waste segregation and recycling is one crucial aspect most individuals ignore either because someone else should do it for them or it is too dirty a task or it is too tedious and time-consuming to do it oneself. Segregation can help one realize the amount of dry waste generated and thereby put conscious effort to reduce so. Bio-composting at home takes only a small corner. The compost takes care of all the wet waste generated. At the end of a few months, it gives back good fertilizer for plants or could be sold to local nurseries.

Recycling grey water and using it either for flushing purposes or for irrigation and gardening could be another way where we can try to reduce the stress on domestic water usage. This may not be applicable in places of municipal sewer connections, yet to be aware of options is always beneficial.

Blackwater from the toilets could be dealt with too, however, due to hygienic reasons many people refrain from this. This is best left to the care of municipality

wherever possible. Alternatives systems for channelling black water on individual plots could be twin soak pits connected to toilets or sewage treatment tanks. There are many newer treatment bio-digestors available for this purpose.

Stormwater can be filtered and diverted into the ground to recharge the ground water table wherever possible. Not all outdoor areas need to be paved, some could be detailed to capture stormwater.

Rainwater can be filtered and harvested into underground tanks. This can be put to use in months of low ground water table. All new apartment buildings have made this aspect compulsory.

Wherever possible, solar powered lighting can be used coupled with a well-designed day-lit space. This can be opted for all structures where the usage of the building is on a regular basis. This is energy and finance saving in the long run. Some cities in India even purchase back the excess power generated into the grid. For factories or commercial spaces this could be a big solution considering the scale of usage. Buildings like weekend homes or farm houses visited less frequently may find this option a rather heavy investment with no return.

Ecological landscape around the buildings can include native varieties of fauna that help in propagation of pollinators, birds, and insects.

Greens in and around any building help reduce solar gains and provide freshness and breathability to the people within.

Sustainable architecture stems from a sustainable lifestyle. A low energy-intensive lifestyle will seek an architecture that consumes less energy. A solar-powered home with minimal lighting fixtures could be termed less energy intensive in comparison to a house designed with many accent lights running on grid power.

The uniformity of construction worldwide has also led to a global loss of indigenous and local craftsmanship. As artisans struggle to contribute to society, identity loss is experienced across contexts. Unable to sustain themselves in village economies, rural populations have been increasingly migrating to urban

areas to look for menial jobs. **Local arts and skills** can be utilized to construct certain parts of the building. This will ensure local job opportunities for skilled and unskilled labour. This also eases maintenance that may be needed in the future.

A tab should be kept on the **quantity of materials used**. This will not only ensure lack of wastage of material and finances, but also **conscious consumption**. We may be able to afford certain resources, but they are non-renewable and must be consumed consciously. Conscious consumption also means cutting down on as many unnecessary ambitions and wants. To give a classic example of this, many glass-cladded high rises have cropped up in Indian cities and towns only to get their interiors heated as hot as ovens and later adding heavy-duty air conditioning to cool the entire volume of air. This is a classic example of copying the physicality of another building located elsewhere in the world and 'wanting' the same without questioning the need to do so. This is also an example that portrays how an architectural ambition (either from the client or the architect) gone wrong can lead to problems in the long run.

Designs have gone global and this has led to a loss of visual identity. Whether that is due to a newer alien technology or a newer skill set, the world has become visually homogenous. An architectural design in the city of Mumbai may look exactly like a building in New York or Miami. Most people today wish to make a house "looking" like a house elsewhere in the world without considering climate, skill, material palette, other resources of their location and geography. A superficial look can be created but an **identity of the user** cannot be fixated on just a façade or the look.

Similarly, respecting a region's geography, topography, and climate is critical to developing sustainable and impactful solutions. The specific biodiversity adapted to a particular climate has served as a resource base for consumption and construction for millennia. The people of such ecosystems also develop skill-sets to tap into these seasoned natural resources to address their problems. Furthermore, such established solutions ensure that the ecosystems are sustained without external input, generating little to no waste. These **circular systems of resource management and economy**, adopted by indigenous tribes across the globe could serve as the main source of discursive inspiration.

Thus, a discussion around sustainable architecture is incomplete without addressing the consumption patterns inherent within current architectural practices. Waste generation, coupled with the lifecycle analysis of each material consumed and each structure built should also be considered when presenting building solutions. Passive strategies should be the norm. Using renewable energy to run certain aspects of a structure would reduce the use of exhaustible resources, ensuring a smaller ecological footprint. Moreover, considering that the climate crisis has increased the frequency of natural disasters, disaster mitigation is a facet that cannot be overlooked anymore.

Any material or technology newly created must be given an ample amount of research and development can happen to test its usability. These must only be developed along with a fool proof plan of going back to the environment without damaging the ecology even if handled recklessly i.e. at the time of discarding them. Having a purist approach seems an extreme viewpoint, however, it is the only way we can steer the extremely dire situation to a manageable situation sooner by being optimistic that it still can be improved.

## A life lived through examples

As an architectural practice based in and around Palghar and Thane districts of Maharashtra, we are fortunate enough to observe and learn various aspects of sustainability from the Warli tribe predominant in these districts. These tribes have sustained through centuries with indigenous wisdom of nurturing nature and in return nurturing themselves. They have always known the art of conserving forests, protecting water sources and living a peaceful symbiotic life with all the elements around them.

These tribal communities divide themselves into smaller groups at the scale of villages and 'padas' (smallest unit of a village as called in Palghar district) where these groups take responsibility for their surroundings, the context, the biodiversity, the water bodies, the air quality, the forest and every other element on which their survival depends upon directly. This decentralized approach has given tribes a better hold on their rights and responsibilities as members of the

community as well as a member within the bigger ecosystem. All can see the direct relationship between the context and the tribe. Similarly, their actions and their consequences are easily noticeable in the limited metaphysical boundaries of these tribal settlements. This leads to communities being highly sensitive towards their surroundings.

How a sustainable lifestyle looks, can be understood with a few examples from their day-to-day life. The Palghar Warli have inhabited areas where rainfall is plenty, rice subsistence farming is carried out majorly and cattle are family members. The Warli tribe from the state of Maharashtra are well renowned for their tribal Warli art. This art form like many others is so immersed in sustainability that not just its materials are cyclic and natural, but the thought process behind each painting is rich too. A painting named "ghar" (home) shows all that a Warli Adivasi thinks of as his home.

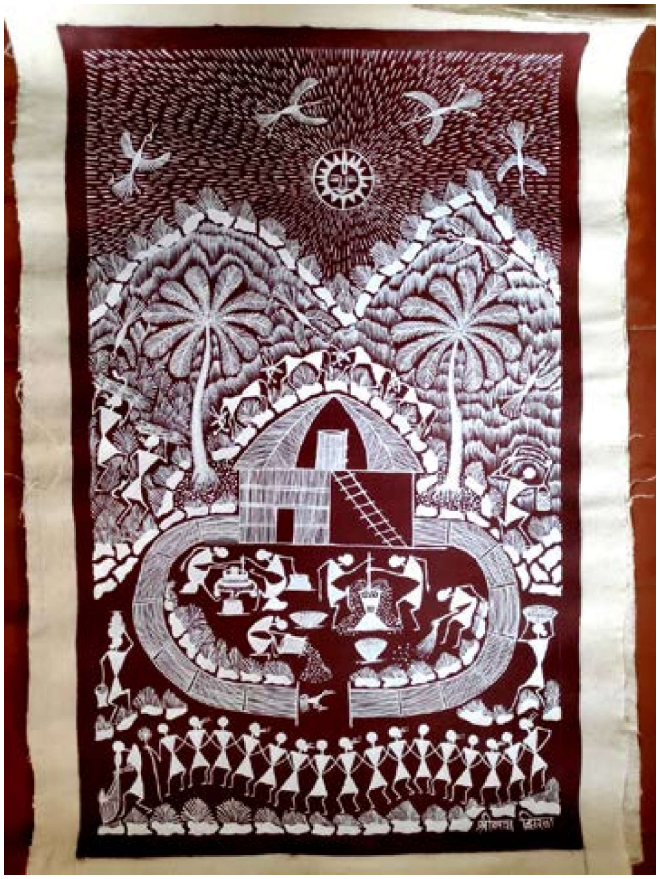
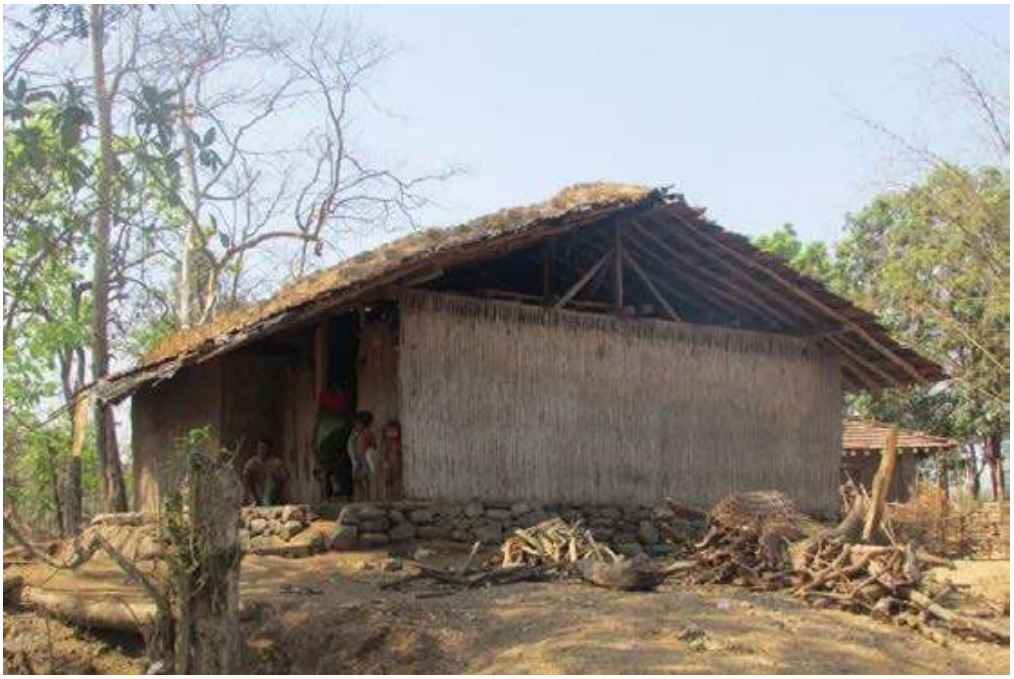


Image 01 - Warli painting depicting a Warli "ghar".

This painting is not restricted to the 4 walls that define their house boundaries but includes the cattle, the chicken, the backyard farm, the fields, fellow villagers, the forest, the birds, the sun and everything they see around themselves. The materials used are geru (burnt red earth powder) as the background paint on which crushed rice paste is traditionally used for painting the stick figurines which are the identity of a Warli painting.

Another example of sustainable lifestyle is the use of karvi (a type of reed) used by these tribes as a walling material with local mud and cow dung. This is world-wide recognised as the wattle and daub technology of building.



Images 02 - A wattle and daub Warli hut.

These reeds are hand woven in a framework of bamboo or timber to form a tough partition which is then smeared with a paste of mud and cow dung to protect these panels from rains and other moisture related elements. The cycle of consumption begins with the reeds obtained from the forest made into walls with no energy other than muscle power. Every year these walls are re-smeared with mud and cow dung after rains in Diwali as a village community activity. The life of these walls is 3-5 years if exposed to rains and even more if designed such that they should not come in contact with the rains. Once the life of these karvi partition walls is over, the resident effortlessly dismantles the walls (which need

replacement) and put them into the fields for decomposition. The karvi, mud and cow dung cycle are thus decomposed with no damage to the environment. In fact, it adds value to the farms as manure.

The waste disposal process employed by the warli Adivasi is exemplary too. The kitchen is traditionally never a part of the core house. It is a lean to sloping roof extended from the core house. This easily segregates the water element within the house. A nahani or a bath area is also provided outdoors near the kitchen but with a different access. The waste water generated from both these areas is diverted to a fenced backyard where vegetables and fruits needed by the family are grown.

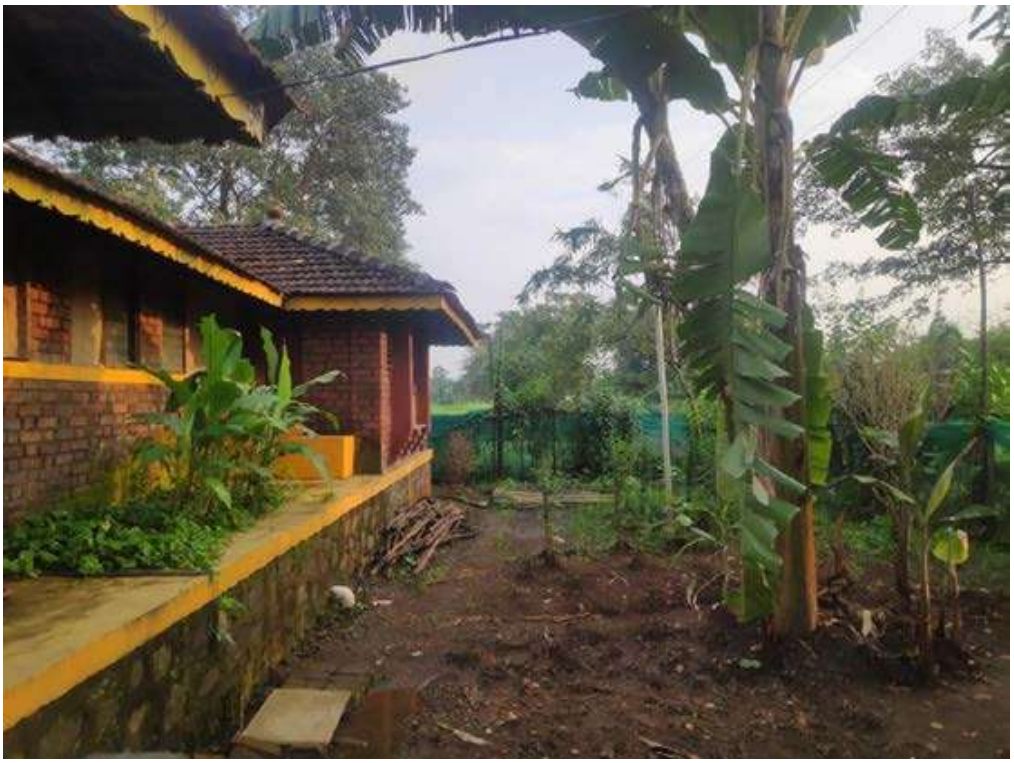


Image 03 - Backyard garden and waste water system.

A trench is dug from the outlet source to these individual plants. The waste of the kitchen and bath is gold for the plants. These plants grow extremely healthy with no pesticides or insecticides sprayed on them.

Another interesting way these tribe supplement their protein requirement is through consumption of fish from a network of sweet water streams. There are many fresh water fishes and tadpoles in the streams. The Adivasis have devised extremely ingenious fish catcher that can be put upstream to entrap fish. This is a handwoven cylindrical bamboo design.

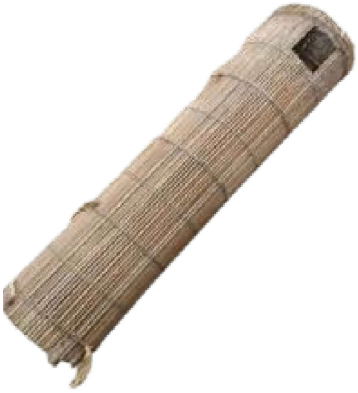


Image 04 – "Bhotad" or a cylindrical fishing net.

The 'Bhotad' is designed so sensitively that there is provision left for tadpoles and baby fishes to escape the catcher so that they can grow and populate the stream. This is a sustainable approach through the design. However, if a tribe is not this foresighted then its extinction is obvious.

The systems of sweat equity or 'shramdaan' are exemplary and progressive. For community structures like temples, the tribal village carries out some renovation or repair or extension works at regular intervals. The sole purpose of doing so is to pass on the traditional building skills from the older generation to the younger ones.

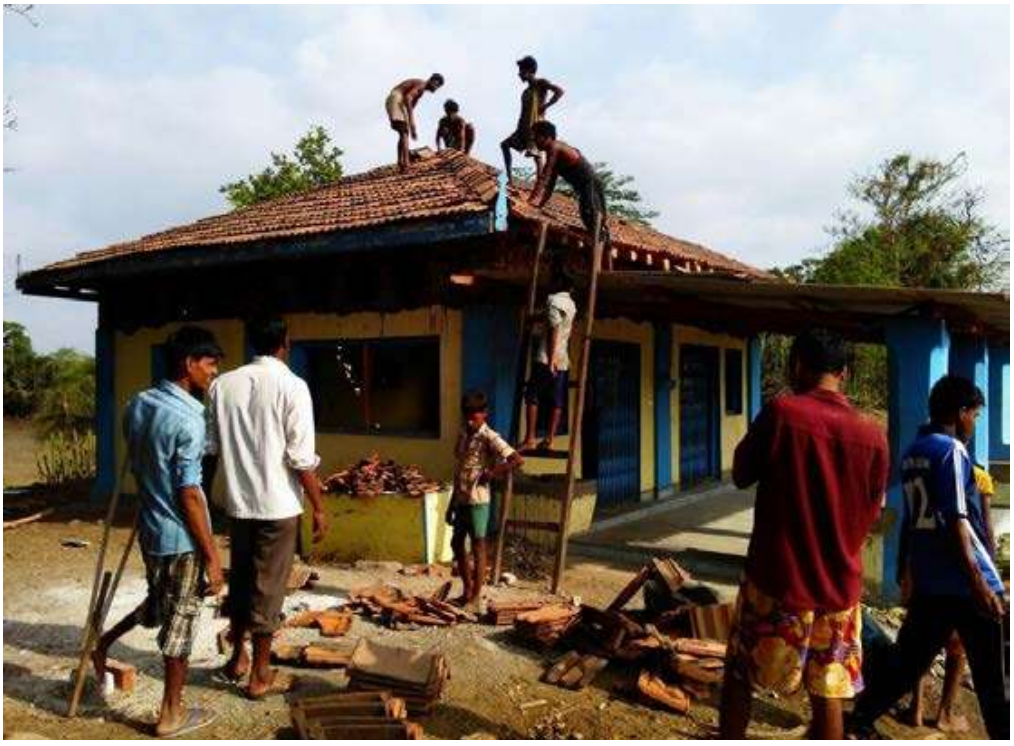


Image 05 – A Warli temple under extension.

All tribal know how to build their own houses and never need an architect or a contractor to execute their houses.

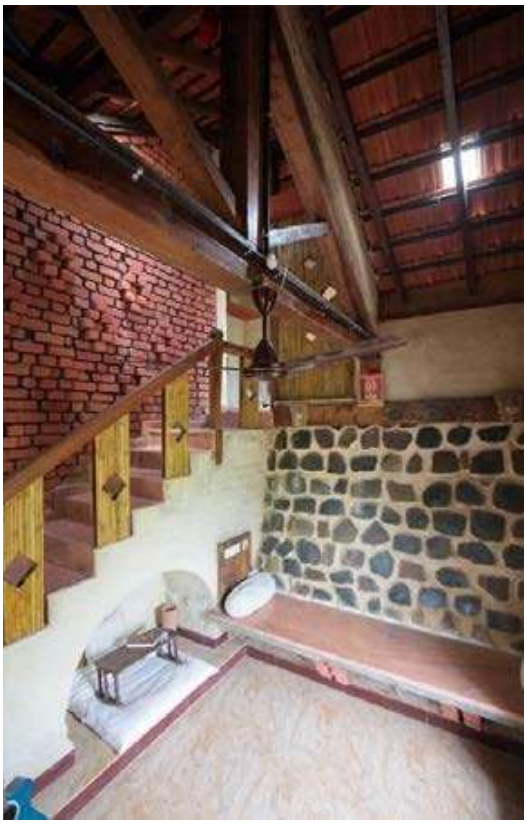
Being exposed to such a rich sustainable lifestyle, we absorbed a lot of insights from the Warli tribe which we tried to translate in our architectural practice. A few aspects and elements of our projects are showcased in this article to provide alternative solutions and approaches to the incorporation of sustainable techniques and ideas in our practice.

## An example of sustainable architectural practice

In a certain project, the land owner wished to make a small house on his newly purchased farm. We encountered a barren parcel of land with a heavy slope. Hot and dry winds carried away the topsoil during summers and water eroded the slope during monsoon. With no tree roots to hold the soil, the soil degradation over the years was inevitable. As a sustainable approach, the first and foremost decision was to arrest the soil erosion rather than cutting the slope and building the house.

Image 06 – The pre-construction slope after growing tur and vetiver grass on the top level.

Image 07 - The house post-construction.

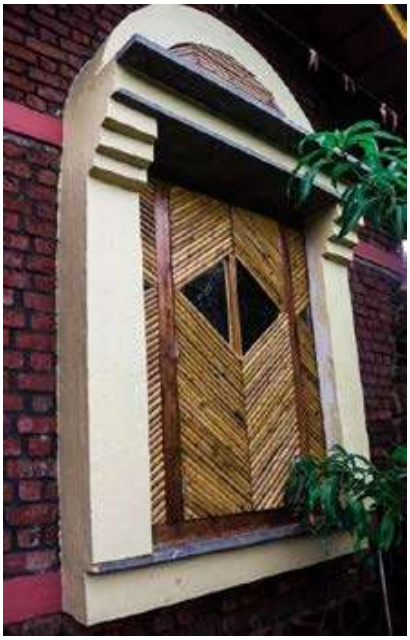


A retaining wall was constructed to arrest the soil erosion along with plantation of tur daal and vetiver grass that have deep tap and fibrous root systems respectively. The next step was to construct the house with this retaining wall as an elemental wall within the house.

Image 08 - The stone retaining wall as seen from within the house.

A bore well on site caters to the water requirements of the house while house is designed to collect the rainwater from the sloping roof, purify it and send it back to recharge the bore well and this in turn recharged the ground water table.

Image 09 – Rain water harvesting and borewell recharge.



The window frames and shutters were made by the local carpenters using waste wood sections from the saw mill along with split bamboo. This not only reduced the cost, but discouraged the cutting of newer trees.

Image 10 – The waste wood window with split bamboo.

The house is constructed using natural materials and finishes through the local labour incorporated the use of five different timber species. This is consciously done to reduce the pressure of consumption on a single species. Every species of timber has a specific strength area; some are good to take tension, some in compression, some in grain texture, some in water resistance. These have been used appropriately in different locations for different functions.

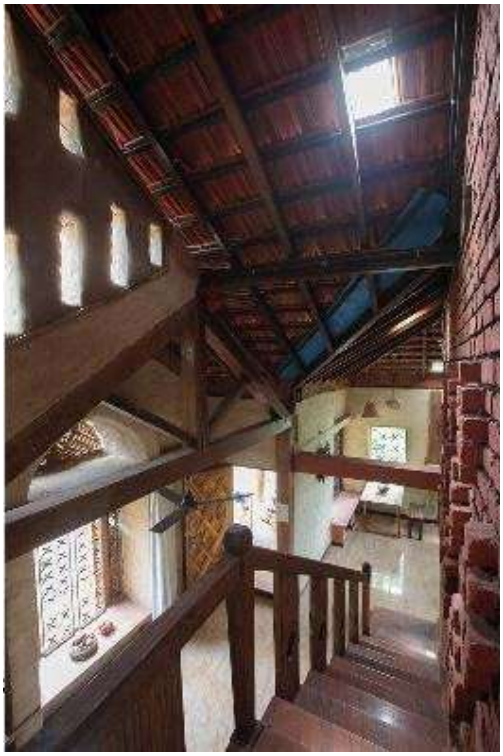


Image 10 – Various timber species used.

All the species used in the house construction were replanted on the farm thus completing the cycle. A small effort makes a big impact.

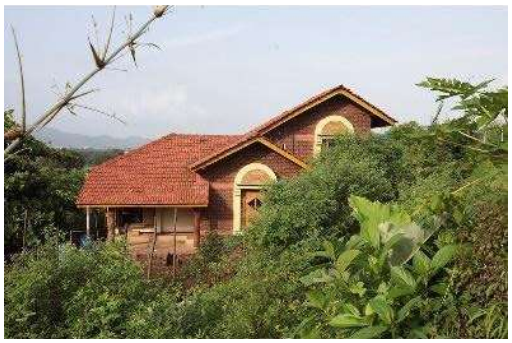


Image 11 – Farm area with house in background

The barren farm land around the house was also converted into a food forest along with native plant species. Over the span of 3-4 years, many birds, insects and pollinator biodiversity has made home in this farm.

This is just one of the many possibilities which got materialized on this parcel of land with inputs of conscious and sustainable architecture. The possibilities are endless when one views from the perspective of sensitivity and compassion towards all animate and inanimate beings that make our ecosystem. Conscious awareness is the first step towards a positive change.

## Conclusion

Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their needs. Sustainable architecture is one of the many parts that fall under the umbrella of sustainable development.

Every individual in our global society needs to spread awareness of our current predicament to encourage a responsive and sensitive approach towards a consciously built future. This awareness should be bolstered by consideration towards not only our species but also the biodiversity with which we share this planet.

There are many individuals and architectural practices which are now taking an initiative to revive the age of wisdom of traditional knowledge, researching on the cyclic practices of natural buildings.

A civilization that does not prioritize sustainability is doomed to fail. As the most sustainable forms of architecture are derived from sustainable practices of individuals and communities, there is now an urgent need to look into the practices of native societies in India and around the world. Tribal communities, with sensitivity to their own contexts, are objectively more progressive and sustainable in comparison to the insensitive architecture and heavy energy consumption that defines urban settlements. As such, a radical change in our lifestyles and perspectives is required to address the burgeoning problems plaguing our species.

As soon as the 1990, a cartoon series named 'Captain Planet and the Planeteers'3 had started screening where Captain Planet and his five Planeteers saved the planet from pollution that man was causing at an alarming rate. We have finally reached the pinnacle where we have not left any stone unturned when it comes to polluting all means of land, water and air. Unfortunately, we do not have a 'Captain Planet' to come and save us but his message of "The power is yours" still stands loud and clear.

[**Note**: All photo credit belongs to Design Jatra Architects and Planners]

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