A GLOBAL APPROACH TO VERNACULAR PRACTICES
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research report

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FOREWARD

In the spring semester of the academic year 2016/2017, I attended the Msc2 design studio Housing under the Himalaya. During the experience I discovered my interest in the link between affordable construction in developing countries and the world of vernacular architecture. I’ve been fascinated by the sense of deep truth and honesty that spontaneous “architecture without-architects” emanates and at the same time by the almost-accidental holistic approach that it embodies. It boasts the incredible feature that its value is generally determined by its non-value in term of materials and construction process – and that this simple characteristic determines a revolutionary quality in terms of sustainability.
POSED PROBLEM

The construction sector is one of the main contributors to greenhouse gas emissions\(^1\) and the built environment consumes over 40\% of all energy worldwide\(^2\).
Almost each phase within the buildings' life-cycles imply an enormous exploitation of resources - from extraction, manufacture of materials to building construction, usage and dismantling.\(^3\) The emissions are expected to drastically grow during the next twenty years.\(^4\)
Despite its impact on the environment, the sector is extremely vulnerable to the effects of global warming. It is basically threaten by the same problems that in large part it's contributing to cause.
There is an increasing risk that the current architectural trends - in terms of stability, design, technology and materials - may not be suitable to sustain the effects of future climate changes.

South Asia - and India in particular - have been considered the most vulnerable part of the world. It has been assessed that around the 50\% of its population, in the in the period between 1990 and 2008 was affected by at least one type of natural hazard caused by global warming.
Even though the highest number of catastrophic events was experienced by Bangladesh and Nepal, India is the country that paid the the major amount of damages in terms of expenses: more than 26 billion dollars.
According to these few data reported, it appears immediately clear how the global responsibility should be particularly emphasized for the region – even more if it's taken into account that the countries of South Asia produce very small quantities of CO2 compared to other states.\(^5\)
For example, according to a report of the INCCA (Indian Network for Climate Change assessment), India accounted only 5\% of the world emissions on 2010, behind USA, China (which emitted almost four times more) and Europe.\(^6\)

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\(^1\) “the energy used to manufacture and transport building materials represents nearly 8\% (350 PJ per year) of all primary energy used in the UK, whereas 50\% of all energy consumed is attributable to occupation of the dwellings” Quote from: Morel J.C., Mesbath A., Oggero M., Walker P.; “Building Houses with Local materials: Means to Drastically Reduce the Environmental Impact of Construction”; Pergamon; Elsevier Science; Vaux-en-Velin, Cedex; 2001; p.1

\(^2\) Khanna P, Nagrath K, Mangrulkar A; “Climate and Construction – An Impact Assessment”; Project report to CDKN; Development Alternatives Group; 2011; New Delhi; p.7

\(^3\) Morel; “Building Houses with Local Materials: means to Drastically Reduce the Environmental Impact of Construction”; p. 1119


\(^6\) Department of Environment, Science and Technology (DEST) of Himachal Pradesh; State Centre on Climate Change (SCCC); “State Strategy and Action Plan on Climate Change”; Government of Himachal Pradesh; Shimla; 2012; p. 91
The chart shows the percentage of greenhouse gas emitted by the fourth most polluting continents/subcontinents in parallel with the amount of population. Data collected by the World Research Institute in 2013.
Pankaj Khanna, Kriti Nagrath and Amol Mangrulkar, from the Developing Alternatives Group, reported in their article “Climate and Construction – An Impact Assessment” that the construction sector is developing very rapidly in the region and it contributes to more than 20% of the total annual CO2 emissions of the sub-continent.

The majority of these emissions are generated from the industrial processes of only a small number of products, namely steel, bricks and cement.

Due to a shortage of around 40 million houses, the impacts on the environment are destined to grow, especially in small- and mid-size urban contexts, tackled by mass migration from rural areas and devoid of means to contrast it.

The so-called “Himalayan hill towns” - whose ecological equilibrium is particularly fragile - are facing the most acute and critical effects.

The Kullu District, in Himachal Pradesh, is a perfect example of it. The area and its existing built environment will be considered case-study of the research and design projects.

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Natural hazards have always been a constant presence in the history of the region but nowadays the gradual-but-constant urbanisation (strictly linked to the fast increase of population and tourism) – contribute to generate several new risks.

According to Ashwani Kumar, researcher from the department of Architecture and Planning at the Malaviya national Institute of Technology, the increase of population, and the rapid urban sprawl linked to it, are the major causes of vegetation depletion, waste generation and air pollution in Himachal Pradesh.8

One of the main consequences on the built environment is that climate-responsive traditional architecture, based on locally available materials has been gradually and rapidly replaced by more dense urban fabrics, mainly composed of generic reinforced concrete and burnt brick masonries.

The shifts linked to the universal civilization9 are dramatically fast in the district as well as in the whole region.

The ongoing process is lowering the quality of buildings both from the cultural (loss of regional identity and landscape specificity) but also environmental (namely from the sustainable and bioclimatic) points of view.

The modern, but still vernacular, architecture meets tastes and accommodate lifestyles of contemporary users but it’s more and more unsuitable to ensure safety and comfort to them.

The harmonic relation between natural landscape and man-made alterations is gradually being substituted by a sort of arbitrary super-imposition of structures.

As researchers from the School of planning and architecture of New Delhi - referring to some modern interventions - asserted: “It is not uncommon to find buildings in the mountains that are similar to their counterparts in the plains and have almost nothing to do with an appropriate design for the mountains. Often technology and materials from the plains are used in the mountains, resulting in poorer buildings.” 10

The phenomena of migration, climate change, exploitation of natural resources and global civilization are closely interrelated. The summary of their effects, together with the natural processes (climate, precipitations, earthquakes) compose the complex request that is demanded to architects and researchers active in the area.

The scope of the project is therefore to find a solution to (at least some of) them in the form of architectural actions that take into consideration what is already part of the local practices but that, at the same time, adds new values to them.

8 Kumar; ivi
10 Gupta V., Singh R.; “Energy Conservation in Traditional Buildings in the Mountains”; School of Planning and Architecture; New Delhi, 1987
The photograph shows an aerial view on the built environment of Sanjauli Town, a slum-city in Shimla, the capital of Himachal Pradesh. (travellingcamera.com)
RESEARCH PROJECT

The primary focus of the research project is to study the local built environment and to understand which elements and archetypical qualities, embodied by existing structures, needs to be kept and transposed into new interventions.

The main hypothesis that needs to be demonstrated is that the methods to adapt the current trend of construction to climate change are already part of the regional culture - and more precisely, that a combination between ancient knowledge and modern innovations can provide both theoretical inspirations and practical solutions to contemporary (and future) problems.

As Gio Ponti stated in an article published on the Italian magazine Domus: “how difficult is for us architects [...] to achieve a result as natural as that of ‘architecture without architects’ that farmers and men of sea have always built with content.” 11

This belief together with the the principles of critical regionalism - namely the strive for an equilibrium between universal techniques and local identity-giving factors 12 - have been both inspiring background and constant theme through the research process.

As it often happens within urban settlement of developing countries, the majority of interventions have been designed and built by non-skilled professionals. Therefore techniques, forms, architectural languages and urban aggregations are the results of the gradual evolution of customs through time.

The term that will be used to describe this specific type of architecture and environment through the research is vernacular.

The word derives from the Latin vernaculus, meaning “domestic, native, indigenous” and/or from verna that means “native slave” and “home-born slave”. It represents the everyday language, the dialect spoken by common people, distinguished from latin, the official literary language. 13

Once transposed into architecture the term acquires several different shades of meaning. According to what Bernard Rudowski states in the preface of his famous publication “Architecture without Architects”, the adjective vernacular can been translated as nonpedigreed-, primitive-, indigenous-, rural-, folk- or even anonymous-. 14

Opposite to this trend there is the cultured architecture, often monumental, exotic (in the meaning of alien to the specific culture/place) and generally conceived by formally-schooled architects.

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12 Frampton; “Towards a Critical Regionalism”; 1983; pp. 16-29
13 Castiglioni L., Mariotti S.; “IL - Vocabolario della Lingua Latina”; Loescher editore; 2008
Through the research process I chose to embrace the definition provided by the architect, researcher and professor Amos Rapoport, author of the book “House, Form and Culture”. He gets to the conclusion that an architecture can be defined vernacular not because of specific language, form, materialization but because of the process that leads to achieve it, similar in every different context. He states in particular that:

“A satisfactory definition of vernacular is more difficult at the moment. The most successful way of describing it seems to be in terms of process: how it is designed and built. […] The peasant owner is still very much a participant in the design process, not merely a consumer.” […] The model itself is the result of the collaboration of many people, over many generations, as well as the collaboration between makers and users of buildings.” […] “Since knowledge of the model is shared by all, there is no need for drawings or designers.” 15

This definition of vernacular opens the field to both historical traditional architecture (more or less autonomously generated in every inhabited area of the world) but also to more modern spontaneous architecture - often strongly influenced by industrialized materials and techniques but still conceived and built by its future users.

In the research these two typologies are defined through the words of Tom Avermaete, respectively: Grand vernacular architecture and Ordinary vernacular architecture.16

15 Rapoport A.; “House, form and culture”; Prentice-Hall College Div; 1969, pp. 1-17

Avermaete introduces such distinction in his text “CIAM, TEAM X and the Rediscovery of African Settlements” where he writes about the theme of the habitat for the great numbers. He uses the two concepts to explain the difference between the longstanding tradition of Dogon in the Sahara desert (field of study of Aldo Van Eyck\textsuperscript{17}) and the transient, informal bidonville (which inspired the anthropological research on the new way of living of the Morrocan and Algerian CIAM groups).

While the second type tells the story of evolution and adaptation of humans’ customs to a specific habitat, the first is obviously a more recent phenomenon. The latter is the architecture that generally characterizes recent urban fabrics of developing areas; places where the fast growth (or massive migration) of population doesn’t allow local governments to provide housing or arrange urban plans in time. The ordinary vernacular architecture introduced by Avermaete is described also by Virginia Fernandez in her article “Reconsidered Vernacular”, while she describes the barrios of Caracas (Venezuela).

She considers contemporary vernacular architecture all the buildings that “solve the urgent necessity of dwelling in the city, through an evolving tradition”, that are “based on the necessity to dwell, cultural aspirations, and ingenuity to adapt to the surroundings” and whose “materials used are simple and relatively standard, using a basic combination of a concrete frame and slabs, clay brick or concrete block infill walls, and a zinc or plastic panel roof.” Furthermore she adds that “The house is usually built by the family and their close friends and neighbours. If the family members work, construction is done on the weekends or in the evenings.”\textsuperscript{18}

The results of this architectural practice is the unauthorized and uncontrolled urban sprawl, a phenomenon that generates new autonomous parts in the cities: the slums. One-eighth of the world population nowadays lives in slums - around 1 billion people in total.\textsuperscript{19} Even though the percentage of slum dwellers decreased from 39 to 30 per cent between 2000 and 2014 – the absolute numbers keep on rising. “The urbanization of poverty” - as defined by the ex-secretary of the United Nations, Kofi Annan - is one of the most crucial global challenges.\textsuperscript{20} Slums, and therefore the ordinary vernacular architecture that characterizes them, are present in almost every part of the world, especially in developing continents such as Asia, Latin America and Africa.

\textsuperscript{17} Dutch architect, one of the protagonists of the structuralism. He participated actively to the CIAM, is a co-founder of Team X (1954) and co-editor of Forum. He rejected the Functionalism supported by the Modernists and claimed a return of Humanism within the post-war architectural designs.

\textsuperscript{18} Fernandez V.; “Reconsidered Vernacular”; The Site Magazine; 2017

\textsuperscript{19} UN-Habitat; “Slum Almanac 2015 - 2016 - Tracking Improvement in the Lives of Slum Dwellers”; PSUP - Participatory Slum Upgrading Programme; 2016

The elaboration of a strategy to first analyse, understand and then evaluate vernacular architecture is a way for foreign professionals, called to work in developing countries, to get closer to local cultures and customs. Both Grand and Ordinary vernacular architecture embody qualities, processes and ways of doing that describe the specificities of each particular context and that, if tackled wisely, are able to avoid mismatches and incoherences while designing and building new interventions.

As Fernandez asserts at the conclusion of her article:

“The product, which is usually what we as architects value about the vernacular, is not as important as the forces that shape it. By expanding the definition of vernacular, architects can participate in its evolution instead of merely trying to replicate or adapt it.” 21
The photograph was shot nearby Kais in fall 2016, it shows a grand vernacular settlement, typical himalayan houses scattered on the hill.
The photograph shows the town of Vashisht, fall 2016, the recent extension of the city is characterized almost exclusively by ordinary vernacular buildings.
MODUS OPERANDI

All the information regarding the built environment of the selected case-study area has been collected from existing literatures (such as articles, books and researches on the theme of urban development in the mid-hill Himalayas\(^2\)), deduced from direct observations during the site survey (November 2016), on photographs and interviewing locals inhabitants / professionals.

The knowledge allows the researcher to get closer to the Himalayan customs and to be able to elaborate two meta-cases that represent both kinds of vernacular architecture. They are hypothetical models, strictly inspired by typical existing residential buildings, that will be represented and examined by means of analytical drawings.

They are designed in detail and embody all the techniques, materials, spatial organization, dimensions of what is already in-place. In order to understand their qualities and achieve comparable results, the evaluation will be based on a fixed structure of features, that are:

- construction process
- organization & programmes
- ratio of mass/void
- transition between public and private
- seasonal transformation
- materialization and embodied energy

\(^2\) Two main references to investigate the vernacular architecture of the area were:
- Morrison S.; Thakkar J.; “Matra – Ways of Measuring Vernacular built forms of Himachal Pradesh”; SID Research Cell, School of interior design, CEPT University; Ahmedabad, 2008
- Dave B., Thakkar J.; Shan M.; “Prathaa – Kath-Khuni architecture of Himachal Pradesh”; SID Research Cell, School of interior design, CEPT University; Ahmedabad, 2013
Ordinary and Grand vernacular architecture
axonometric views of the two meta-cases
CONSTRUCTION PROCESS

The realization of each building will be divided into steps that show methods, tools, personnel and actions that are needed to achieve a finished result. Conceiving an ephemeral case study building not as a mere 3D-model, but as a process of construction, allows the researcher to get closer to the concreteness of the practical reality. Like while sketching or researching-by-designing, the practice of conceiving an architecture-in-progress is a tool to both understand, elaborate and communicate it.

ORGANIZATION AND PROGRAMMES

After describing the procedures, it’s necessary to analyse the product objectively. The first action is the de-composition of both the envelope and the internal volumes. While the envelope gives an overview of the elements that compose the building, the void volumes are associated with programmes that determine the use of space inside/outside of the house. An unique analytical drawing shows clearly where the different functions (such as kitchen, storage, bedrooms, granary, commercial plinths, livingroom etc.) are placed and therefore how much space is dedicated to each of them.
RATIO OF MASSES AND VOIDS IN THE BUILDING

Every form, material and technique generate a different building and therefore a particular balance between void and mass. The goal of the drawings is to communicate both the total surface occupied by the building itself as well as the percentage of actual available living space, divided per floor.

TRANSITION BETWEEN PUBLIC / PRIVATE ENVIRONMENTS

Every culture has a different idea of the relationship between private interior and public outer space. Each part of the building is designed to be more or less introverted according to its programme and there’s always a kind of tangible threshold that divides the two realms. The scheme tries to investigate the level of publicity/privacy within the building compound. These parameters are key aspects to understand both the concept behind the architecture as well as the generative matrix of urban context around it. Often the organization of human settlements is in fact the result of a specific ideas of publicity applied in a smaller scale.
SEASONAL TRANSFORMATIONS

The use of the house and the architecture itself differs through the year. External factors such as snow or vegetation can give an added quality to the house, becoming sort of components of the building itself. Few analytical drawings divided per season will describe the climatic condition and in parallel the coherent behaviour of the building that for example insulates/heat itself in winter and shades its interior from the sunshine in summer.

AMOUNT (AND TYPES) OF MATERIALS / COMPONENTS, EMBODIED ENERGY, EMBODIED EMISSIONS

The last part of the analysis is dedicated to the quantitative calculation of materials the meta-case is made of. The building is divided into three parts: roof, mediator and central core (+ foundation). Each architectural component is firstly described by means of an exploded view and then de-composed into single pieces/subcomponents (in the case of dry/prefab constructions, such as wood) or into initial raw materials (in the case of wet constructions such as in-situ concrete). Once all the quantities have been mapped it possible to associate each piece to a specific process of extraction or manufacture and therefore to a value in terms of embodied energy and embodied CO2 emission. The summary of all the different values allows the researcher to obtain numerical results about the embodied sustainability of the vernacular meta-case and therefore to make it objectively comparable with other existing / newly designed architectures.
Analytical drawings such as detailed axonometries and exploded views are the main means used to communicate the two meta-cases analysed on the various aspects.

The strict structure of categories of evaluation is laid out in a leporello, a sort of booklet conceived as a double-sided long leaflet. It's basically a poster, concertina-folded into 17 pages.

Each leporello tells all the information related to one meta-case of vernacular architecture. It’s a communicative tool that can be read both as a normal book (page by page) or, once unfolded, as a unique sequence of drawings next to each other, all visible at the same time.

This allows the viewer to compare in parallel similarities and differences among the features of different buildings and therefore obtain results.

Each side of the poster includes a different kind of information: while one face is entirely dedicated to the construction process of the building, the other shows a different category of analysis on every page.

The juxtaposition of the two buildings gave quantitative and qualitative results related to construction efficiency, spatial organization, building composition, sustainability\(^{23}\) and climate design. The results were translated into conclusions, namely fundamental archetypical qualities and principles the existing architectures are conceived from.

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\(^{23}\) All the values about embodied energy and emissions of the materials applied in the research are taken from documents issued by the Auroville Earthen Institute, the Indian UNESCO Chair for Earthen Architecture: Maini S., Thautam V.; "Embodied Energy of Various Materials and Technologies"; Auroville Earth Institute - UNESCO Chair Earthen Architecture; Auroshilpam; 2013
META-CASES

As mentioned above, the two case-studies designed and described are inspired by existing structures. Both of them are free-standing residential buildings combined with public functions.

The grand vernacular house, in particular, accommodates a cowshed (called gushala) at the ground floor and a semi-private covered space at the plinth level of the building. The space has been used by the local community as a meeting space, a sort of portico that is parallel to the public street and that shelters the villagers from rain, snow and sun. It’s a threshold which doesn’t belong directly to the more private realm of the house and that gives to the building a urban dimension.

This type of space is not present in the ordinary vernacular typology.

In this second case the plinth is divided into two parts: the back side, more private and related to the main entrances and the public front, that faces directly the pavement or the main road.

The interior of the ground floor accommodates usually storages, garages, commercial activities or workshops of craft-men. The public realm of the street in this second case seems to physically enter the envelope of the building.

use of the plinth within the two different case-studies:
- gathering point for the community in the grand vernacular building
- commercial space / craftmen’s workshop in the ordinary vernacular building
Generally, it's possible to assert that the level of privacy of each Himalayan building goes parallel with its height. While the ordinary vernacular architecture accommodates only dwellings at the first and second floors, the grand vernacular typology present a series of storage spaces and granaries placed both on mezzanines and on the whole first floor. The building, in fact, is designed to contain all kind of supplies for inhabitants and animals during the winter season. These supplies - such as hay and straw - work also as insulation materials that helps to keep the interior warm in the coldest months. They are gradually consumed by inhabitants or animals before the summer, when such insulation is not needed anymore. Only the last floor accommodates the actual residential space within the traditional building. As stated by Pratyush Shankar, in his article “Understanding Change in Himalayan Vernacular Houses”, the rooms are considered sorts of refuges. Their interior is dark because of the small windows and therefore used only for cooking, sleeping and resting.24

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24 Shankar P.; "Understanding Change in Himalayan Vernacular Houses - An Appraisal of Uttar-kashi in View of Global Connectivity and Natural Disasters"; 3rd International Seminar on Vernacular Settlements; Surabaya; 2006
Both typologies of houses are basically a series of two/three/four modular rooms per storey, namely cuboids stack to each other with flexible (interchangeable) programmes. They are accessible by means of a verandah: an architectural component that connects the body of the house with services (stairs, bathrooms) as well as accommodates important living functions. The verandah of the ordinary vernacular building is generally open and used like a balcony, while the one of the grand vernacular house should be considered integral part of the interior. Like granaries and mezzanines, it’s used to store supplies (especially in the northern side of the house) but also as actual living space, both in summer, as shadowed terrace - and in winter, when shutters permit to achieve a completely enclosed space. The use of its space changes drastically according to the season. Given that rooms are used as warm sleeping spaces only, the verandah becomes an important buffer zone, where inhabitants spend the majority of their daytime. This spatial description isn’t valid for the ordinary vernacular house. The rooms within the second building are in fact definitely larger and well-lighted, capable to accommodate all kind of domestic activity.
The last accessible spaces of the buildings are the top ones, closely related to the roof-typology.
The grand vernacular architecture presents a particular pitched roof that lays down directly on the verandah but that, at the same time, leaves a void under the central body of the building. This space is a sort of mezzanine, used as storage but also as loft-bedroom.
The upper limit of the ordinary vernacular architecture, on the other hand, is a habitable open-air terrace that accommodates technical devices but also a temporary storage shelter. It’s conceived to be cheap, flexible and easily constructed but also convertible into a floor of an interior surface, this happens in case of vertical expansion of the house.
MATERIALIZATION

The second part of the research investigates the materialization of the two buildings. A substantial difference between them appears immediately clear: the traditional construction is entirely made of a dry assembled, combination of wooden beams and slate stones, while the ordinary vernacular building has a wet structure of in-situ reinforced concrete combined with an infill in kiln dried bricks and mortar. The tactility of the two buildings is therefore completely different as well as their ability to withstand the several types of natural hazards that could possibly struck the Kullu district in the future.

As above-mentioned, both of them are divided into three main architectural components: roof, mediator (verandah) and central core (body).

ROOF

Both roofing typologies are capable to protect the house from the heavy rains during the monsoon and at the same time to keep (partially) the snow during the winter season.

The air trapped into the mantle of fresh flakes operates as a temporary horizontal insulation layer, with an U value that can reach 0.12 W/m²K.

The pitched roof of the grand vernacular architecture has a load-bearing structure made of wooden beams and stones. It could be divided into three segments, one per each room. The central one appears slightly smaller than the other two.

The roof is composed by around a thousand shingles in slate stone (average dimension 50x100 cm) and by more or less one hundred of timber beams with length in-between 2 m and 10 m. An integral part of this roof is the ceiling that separates the more external surface from the interior of the house, it's made of more than 500 wooden tiles with a dimension of 3x20x270 cm.

When the gap that results is used as storage space, filled with materials or supplies, it becomes also an extra insulation layer, above rooms and verandah.

The particular type of roof is not meant to be airtight and the house lacks a chimney to expel the smoke produced by the fireplace located in the centre of each room (simply composed of one large stone).

The smoke rises and flows within the beams: the process scorches the wood and alters its surface modifying its permeability. The beams became waterproof and therefore with a longer life-span.

As already mentioned, the roofing structure of the ordinary vernacular architecture is constructed exactly like any other horizontal structure of the house. It's basically a concrete slab of around 130 m² (17.5x7.5 m), pre-conceived to became future interior surface in case of vertical expansion of the house. The re-bars of the underlying pillars proceed partially beyond the slab, allowing the future construction of a structure on top of it.

In between slab and pillars a ring of horizontal beams is present.

The total, average amount of material needed to build such roof consist in 27.5 m³ of gravel, 14 m³ of sand, 10400 kg of cement, 4140 litres of water and 1545 kg of steel25 for the reinforcement.

On the top few objects and systems are placed, namely a black tank of fresh water (pumped up,) heated by means of solar collectors (and than employed for showers and sinks), a storage shelter and a canopy that covers the staircase, both made predominantly of corrugated metal sheets and supported by concrete pillars.

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25 Average amount of material calculated based on the data provided by: Trani M.; “Cantieri Edili e Civili - Progetto, Organizzazione, Gestione”; Collana: Fondamenti per L’edilizia; Maggioli Editore; 2012
roof construction phases:
composition of shingles and beams in the grand vernacular building
casting the concrete slap in the ordinary vernacular building
It's the component that determines the accessibility within the architecture and connects the upper floors with the ground level. It includes all the spaces and elements designated as paths to reach the entrances plus all the surfaces that cannot be actually catalogued as living indoors, roofs or outdoors areas.

In both meta-cases, in particular, the mediator consists of a combination between verandahs and staircases. Both components in the historical grand vernacular architecture are made of timber, differently articulated in each floor.

At the first floor, the mediator serves two sides of the building: the south side and east side, where all the entrances of the rooms and the staircase are respectively placed. The verandah in this case is a cantilevered balcony of 1.5 m, supported by a system of beams wedged in the thick walls and positioned during the construction process.

The same type of load-bearing structure is applied for the verandah of the second floor but in this case the medium is a larger space that flows all around the central core, with an average span that varies from 2.40 to 2.10 metres.

The central room of the building body is considered part of this space since on the southern side it’s directly connected to it, without any partition.

Two wooden boxes are added on the southern and eastern side. They are a bathroom and a toilet cabin, both supported by three timber pillars.

The grand vernacular mediator is composed of more than 600 wooden pieces, namely 128 panels (50% of them 120x50x5 cm, 50% 50x50x5 cm), 136 vertical supports (50% of them 120x22x12 cm, 50% 78x22x12 cm), 91 floor beams (some 370x17x17 cm, some 370x17x10 cm) and 286 wooden tiles (some 270x8x20 cm, some 215x8x20 cm).
The equivalent architectural element in the ordinary vernacular house is more simple and repetitive. Every floor has 31.5 m² of verandah, 2.5 m width, organized on two sides of the building, namely north and west. The latter side, the smaller one, accommodates the staircase, that occupy almost all the spaces on the face of the building. The verandah has a regular walkable width of 2.5 m, plus 0.5 m of short external cantilever.

Slabs, beams, pillars and stairs, that compose the mediums, are entirely made of concrete and the average amount of material needed for the construction of these components is: 45 m³ of gravel, 23 m³ of sand, 1640 kg of steel for reinforcement, 6760 litres of water, 16900 kg of cement.
CENTRAL CORE

It's the main body of the building, where the most enclosed and private spaces are. Both in ordinary and grand vernacular architecture it consists of a series of modular volumes, placed close to each other, stacked on three rows. Despite this, the ratio between mass and void is really different among the two typologies. While the walls of the ordinary vernacular architecture are 24 cm thick and the inner living space is more than 40% of the total floor surface, the equivalents in the grand vernacular house are 60 cm thick, with an indoor space that is only the 14% (60% verandah, 38% walls) of the second (residential) floor. The construction system applied to build the grand vernacular walls is called kath-khuni (in english: cator and cribbage). It's a wide-spread system among the mid-himalayan altitudes, employed to almost each type of traditional constructions (also temples and public buildings). It has been developed through the centuries to combine local available slate stones and soft deodar wood into earthquake-proof and timeless walls (some of them lasts since 200 years ago).

Such construction technique was carried on historically by a specific group of craft-men called mistris, sort of himalayan specialized carpenters whose knowledge was transmitted orally from fathers to sons. Each wall is composed of a series of parallel beams, placed two per time on top of each other and successively fastened by means of non-rigid wooden joints. During the construction process the void spaces in-between the skeleton of beams are gradually filled with slate stones.

exploded view
corner detail of a kath-khuni construction

26 Dave B., Takkar J.; Shan M.; “Pratha – Kath-Khuni Architecture of Himachal Pradesh”; SID Research Cell, School of interior design, CEPT University; Ahmedabad, 2013
Even though the thickness of the walls remains always the same, the balance between heavy stones and lighter timber beams changes according to the height of the building. While the ground floor is almost completely made of rigid stones, the upper floors are composed of a combination of the two materials. This precaution makes the building heavier at the basement and lighter at the top, increasing its anti-seismic quality. In order to further unburden the structure at the top floor, some voids are left in-between the walls. They are transformed into storage compartments or windows.

The thick walls play an important climatic role in building: the amount of stones constitute a huge thermal mass which contribute to keep the interior warm in winter and cold in summer - because almost always shadowed by the overhanging verandah.

The quantity of timber and stones employed to build the central core of the building is impressive: 528 timber beams (202 for the 2nd floor, 228 for the 1st floor and 98 for the ground floor) and 480 m³ of stone (56 m³ for the 2nd floor, 56 m³ for the 1st floor and 458 m³ for ground floor, plinth and foundations). The intermediate floors are made entirely of wooden rafters covered with long tiles and the internal cladding is made with mud or - at the top floor - with a double layer of wooden planks.

The central core of the ordinary vernacular architecture on the other hand is characterized by a vertical structure composed of twelve RCC pillars per floor with an infill in kiln fired bricks and mortar, combined with an horizontal structure of RCC beams onto which a floor slab is placed. The construction of the latter is identical of the one already described for the roof. Moreover while the interior walls and ceiling are plastered, the exterior has an exposed brickwork. The ground floor has an open façade towards the main street, constituted of rolling shutters and full-height french shop windows, appropriate for commercial activities.

All the other openings within the façades are windows with steel frames and single glazings (8 large ones, 9 small ones) and 11 wooden doors (on the northern-side only).

The (deep) foundation are made of simple footings, one under each column and the total amount of material needed for the construction of central core (+ foundations) is: 72.5 m³ gravel, 36 m³ sand, 27100 kg cement, 10750 litres of water, 2320 kg steel and 61,5 m³ of kiln fired bricks.
CONCLUSION

The research project led to several qualitative and quantitative results onto the comparison between the two houses. In general, the grand vernacular architecture appears more appropriate to withstand climate and natural phenomena that are typical of the Kullu district; nevertheless, the ordinary vernacular building seems generally more compatible for accommodating the needs that the modern lifestyle requires. In terms of sustainability, carbon footprint and embodied energy both of them have strengths and weaknesses.

Regarding the climatic design, it’s possible to assert that the grand vernacular architecture shows a series of specifically developed strategies to shelter and protect its users, and does it in a totally natural and bioclimatic way. The average U value (Thermal transmittance) of the thick walls combined with an external buffering zone (wood, plus hay or straw) is $0.24 \text{ W/m}^2\text{K}$. The same calculation, applied to the ordinary vernacular meta-case, gives results eight times higher. In this case the infill with simple kiln dried bricks combined with a thin layer of internal plaster doesn’t have any insulation quality and the average U value on the southern side appears to be more than $2.00 \text{ W/m}^2\text{K}$.

Detail (grand vernacular):
- Verandah as buffering zone
- Snow and hay as additional insulation layers

27 According to www.zebra-monitoring.enerdata.eu/overall-building-activities/wall-u-values-building-codes for example, the value would hypothetically meet the minimum requirements requested by the Italian, German and French governments.
For what concern the safety of the building in sight of future natural hazards, the traditional construction technique demonstrated during several historical episodes its ability to endure. For example, as stated in the research paper “Seismic Vulnerability of the Himalayan Half-Dressed Rubble Stone Masonry Structures, Experimental and Analytical Studies”, the modern construction type shows a higher vulnerability in case of earthquakes. The 40% of building stock risks to fall down during seismic events and the percentage of collapses can rise up to 70-80% in case of larger earthquakes with close source-to-site distance. 28

In the article “Understanding change in Himalayan vernacular houses”, 29 Pratyush Shankar, uses the example of the earthquake - that happened in the October 1991 in Uttarkashi 30 - to explain how the majority of buildings that collapsed were poorly constructed RCC structures and how, after the event, local inhabitants started to prefer well established traditional construction systems, despite the scarcity of wood. The capability of traditional kath-khuni to be earthquake-resistant is not only due to its walls/foundation construction but also to the building typology itself, that has a simple, symmetrical and compact form. If the building techniques haven’t been passed on the ordinary vernacular architecture (mainly due to the availability of cheaper materials that looks more modern and up to date); shape, spatial organization and few other anti-seismic tricks 31 did.


29 Shankar P.; “Understanding change in Himalayan vernacular houses - An appraisal of Uttarkashi in view of global connectivity and natural disasters”; 3rd International Seminar on Vernacular Settlements; Surabaya; 2006

30 Uttarkashi is an himalayan city placed in Uttrakhand, similar altitude as Kullu but 200 km (as the crow flies) towards the South-East direction.

31 Such as windows and doors that are directly attached to the lintel.
Notwithstanding the similar dimension of the ground surface, the actual walkable internal living space of the ordinary vernacular building is way larger than the one of the traditional structure. Walls in RCC and brick masonry occupy only the 18.5% of the floor surface, in opposition to the 56% of the kath-khuni construction.

Moreover, onto a total similar surface of 330 m² (around 110 m² per floor), the ratio of outdoor/indoor spaces is opposite. In the grand vernacular house the 70% of the total surface is verandah space and only 30% actual indoor, while in the ordinary vernacular the values are opposite (30% outdoor, 70% indoor).

The vast majority of the space in the modern house is characterized by higher, well-lighted, flexible, non-typified inner spaces. The house is suitable to accommodate a more urban kind of lifestyle which requires indoor spaces apt for several uses. Another important quality that the house present is the possibility to be constructed-in-time, namely incrementality.

The storeys of the building can be built one by one and the house can be enlarged both horizontally and vertically. It expands together with the family who lives in it. During the works for the expansion, the residential building remains a living area but became somehow construction site too.

This quality is important in particular if considered on a urban level; incrementality means the possibility to grow gradually and therefore to densify the urban tissue. If the first necessary archetypical qualities (such as safety in sight of natural hazards

32 Shankar P. (lecturer at the School Of Architecture of Ahmedabad); “Understanding change in Himalayan vernacular houses - An appraisal of Uttarkashi in View of Global Connectivity and Natural Disasters”; 3rd International Seminar on Vernacular Settlements; Surabaya; 2006
and bioclimatic design) have been inspired by the traditional architecture, the modern building shows which spatial requirements and dimensions suit the demand of contemporary families.

Something that is equally common between the two architectures is a honest language: the bare construction (kath-khuni, or masonry) is exposed and not hidden under a cladding.

This feature - that can be defined explicitness and that seems apparently secondary - is actually very important in vernacular built environments. Non-professional builders project their house by literally copying the structures of their neighbours and this makes the vernacular design practice survive and continuously evolve through time. The quality is strictly related to the feasibility and reproducibility of vernacular architecture in the specific context.

Both houses can be designed and built with materials and industrial products that are available locally.

In addition - as demonstrated by means of the construction process scheme - they are possibly realizable by means of non-skilled manpower only and without sophisticated tools that are not affordable for local inhabitants - and even non-available in the ancient times when the grand vernacular architecture was born.

Despite this, in terms of quantity, the grand vernacular typology employs two times more material than ordinary vernacular one. The former is composed in total by 630 m³ of material (144 m³ of wood and 490 m³ of stone) while the latter by only 290 m³ (70 m³ Sand, 140 m³ aggregate, 170 m³ cement, 0.5 m³ steel, 61.5 m³ bricks)\(^3\). While considering this numbers in terms of embodied energy however, it appears immediately clear how the modern structure embodies a larger amount of it: two times more then the grand vernacular building and respectively 670000 Mj, opposed to 330000 Mj.\(^3\)

It’s the energy consumed during excavations procedures, industrial production processes and transportations, that cannot really be applicable to deodar wood and slate stone, generally locally available and kneaded on site.

The second parameter that is worthy to consider at this point are the CO₂ emissions embodied in the material.

The grand vernacular architecture in this case appears more harmful for the environment. The large amount of wood employed in fact should be considered two times, since the trees, when alive, operate as CO₂ sinks that absorb carbon and transform it into oxygen. This fact, together with the timber manufacturing processes and the transportation of stone, makes the CO₂ value associated with grand vernacular house 115000 KgCO₂; a way greater number if compared with the 90000 KgCO₂ of the ordinary vernacular one.

It has been accounted that 90000KgCO₂ is the average amount of carbon absorbed by 90 trees in 50 years.\(^\text{35}\)

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33 Average percentages of material in every type of architectural component (pillars, slabs, beams, roof, foundation) were extrapolated from: Trani M.; “Cantieri edili e civili - Progetto, organizzazione, gestione”; Collana: Fondamenti per L’edilizia; Maggioli Editore; 2012

34 Data achieved from: Maini S., Thautam V.; “Embodied Energy of Various materials and Technologies”; Auroville Earth Institute - UNESCO Chair Earthen Architecture; Auroshilpam; 2013

35 According to the urbanforestrynetwork.org a 10-year-old tree absorbs around -20 kgCO₂ per year
These results are useful to understand which requirements the future architectural interventions in the area should meet in order to achieve a better embodied sustainability as well as to choose correctly materials and applicable building techniques. The conclusions of the research can be finally synthesized by few key qualities, organically above-explained, that are: explicitness, modularity, flexibility, incrementality and feasibility (as well as more generic safety, sustainability and energetic autonomy). All of them resulted directly from the study of the two meta-cases analysed and if applied into new buildings, they will generate a new but non-alien architecture, that is coherent with the cultural and climatic context. They can be considered guidelines that once followed will allow architects active in the field, researchers or simply vernacular builders to avoid mistakes while designing interventions in the area.
The chart shows and compares the numerical results achieved through the study of the two meta-cases.
Reflection

The research must be considered as the investigation on a process to achieve a project that can be applicable also in other contexts. It has a value as design approach in itself.

In other words, the Himalayan valleys of Himachal Pradesh are a valid case study to demonstrate the applicability and validity of the strategy developed, but not the only possible example.

All over the world, especially in developing countries such as other regions of Asia, South America or Africa, it’s easy to find areas where nowadays the population is facing similar issues related to climate change, migration, shortage of materials, environmental pollution and urban sprawl.

More and more professionals are called to work on the themes and therefore to think which could be the best (architectural) solutions to apply.

When this happens, the risk is always that the foreign designer, professionally well prepared but culturally far from the specific context, imports ideas that are locally unknown and that pretend to radically modify the well-established customs - the consequence of such actions is often failure.

I decided to explore an approach that doesn’t solve the problem partially (by means for example of a finished intervention of architecture that substitutes parts of the slum) but that is, first of all, a method to influence local people to build differently.

The trend of the chosen area, as well as of other places, is that the builders are often designers and users too. I think that this quality is fundamental and cannot be overlooked among the design process.

Architects sometimes neglect to consider what is already part of the local culture as starting point of their process of research and development. This fact is one of the causes of global civilization, namely the depersonalization of culture in certain contexts - followed by the gradual loss of traditional specificity and therefore of local identity.

A structured and clear system to generate awareness around the possibilities and solutions that are traceable in traditional patterns is in my opinion a fundamental tool to systematically help professionals in their decision-making process. Every choice will be weighted and confronted first of all with what is already in-place: a way to avoid mismatches and incoherences in the interventions.
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TU Delft / Faculty of Architecture
Msc3/4 Explore Lab 24
A global approach to vernacular practices

Research Tutor: Nelson Mota
Design Tutor: Roel van de Pas
BT Tutor: Hubert van der Meel

Student: Lorenzo Cocchi
GRAND VERNACULAR ARCHITECTURE
grand vernacular architecture

envelope

programmes

kitchen

entertainment room

living space

washroom

bathroom

verandah living spaces + service

granary

storage room

cowshed (gaushala)

semi-covered space for public relation in between verandah and plinth
total area = 180 sqm
central core = 68 sqm
cantilever = 112 sqm
walkable area verandah = 110 sqm
room A = 15 sqm
room b = 11 sqm
internal walls = 26 sqm
inner living space = 14% total floor surface
cantilever = 60% total floor surface
walls = 38% central core

total area = 83 sqm
central core = 68 sqm
cantilever = 25 sqm
walkable area verandah = 21 sqm
storage 1 = 15 sqm
granary = 11 sqm
storage 2 = 12 sqm
inner space = 51% total floor surface
cantilever = 35.5% total floor surface
walls = 56% central core

total area = 168 sqm
(+ 3.5 + 5.5 = 177)
central core = 68 sqm
cantilever = 109 sqm
cowshed 1 = 15 sqm
(+ 11.25 mezzanine)
cowshed 2 = 11 sqm
(+ 6.5 mezzanine)
cowshed 3 = 11 sqm
(+ 9 mezzanine)
central core = 38% total plinth
total area = 180 sqm
central core = 68 sqm
cantilever = 112 sqm
walkable area verandah = 110 sqm
room A = 15 sqm
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central core = 68 sqm
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(= 11.25 mezzanine)
cowshed 2 = 11 sqm
(= 6.5 mezzanine)
cowshed 3 = 11 sqm
(= 9 mezzanine)
central core = 38% total plinth

1. U value verandah + wall = 0.24 w/m²k
2. U value roof above verandah = 0.12 w/m²k
3. U value roof above room = 0.24 w/m²k

winter
21st March

eratio mass and void

public \ private spaces

winter

public

private

verandah on the north side

fresh snow = 0.06 w/mk
snow after a while = 0.12 w/mk
compacted snow = 0.23 w/mk
hay (60/80 kg/m³) = 0.06 w/mk

1. U value verandah + wall = 0.24 w/m²k
2. U value roof above verandah = 0.12 w/m²k
3. U value roof above room = 0.24 w/m²k

1. U value verandah + wall = 0.24 w/m²k
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1. U value verandah + wall = 0.24 w/m²k
2. U value roof above verandah = 0.12 w/m²k
3. U value roof above room = 0.24 w/m²k

livingroom entertainment kitchen

storage 1 granary storage 2

cowshed 1 cowshed 2 cowshed 3

05. B04. B06. B
VERANDAH ON THE NORTH SIDE

- fresh snow = 0.06 w/mk
- snow after a while = 0.12 w/mk
- compacted snow = 0.23 w/mk
- hay (60/80 kg/m³) = 0.06 w/mk

1. $U$ value verandah + wall = 0.24 w/m²/k
2. $U$ value roof above verandah = 0.12 w/m²/k
3. $U$ value roof above room = 0.24 w/m²/k
SUMMER

21st June

cooling scheme

07. 8
sample living scenario
ARCHITECTURE COMPONENTS

pitched roof

verandah / mediator

central core
MEDIATOR COMPOSITION

verandah second floor

verandah first floor
**Embodied Energy and Emissions**

**Slate Stone**
- Specific weight: 2600 Kg/m³
- Emissions: from 0.06 to 0.58 KgCO₂/Kg*
- Embodied energy: from 0.1 to 1.0 Mj/Kg*
- Total amount: 490 m³ = 1274000 Kg
- Total emissions of CO₂: 76440 Kg
- Total embodied energy: 127400 Mj

*the lowest amount has been considered because it’s a locally available material

**Timber**
- Specific weight: 550 Kg/m³
- Emissions: 0.49 KgCO₂/Kg
- Embodied energy: 2.5 Mj/Kg = 1380 Mj/m³
- Total amount: 1825 pieces = 144 m³ = 79200kg
- Total emissions of CO₂: 38808 kg
- Total embodied energy: 198000 Mj

*soft wood, air dried, rough sawn

**Total**
- Total result and comparison (total volume = 630m³)
- Total Emissions of CO₂ = 115250 Kg
- Total Embodied Energy = 325400 Mj

urbanforestrynetwork.org: 10-year-old tree = -20 kgCO₂/year

naturefund.de: Average Petrol car = 2.32 KgCO₂ x 12500 km

- 115250 kgCO₂ = 5700 trees x 1 year = 115 trees x 50 years
- 115250 kgCO₂ = emission of average petrol car x 600.000 Km
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ORDINARY VERNACULAR ARCHITECTURE
ordinary vernacular architecture

envelope

programmes

walkable roof

kitchen and living room

bedrooms

bathroom

verandah living spaces + service

storage room

commercial plinth

garage

semi-covered space for public relation in between verandah and plinth
ordinary vernacular architecture

PROGRAMMES

- walkable roof
- kitchen and living room
- bedrooms
- bathroom
- verandah living spaces + service
- storage room
- commercial plinth
- garage
- semi-covered space for public relation in between verandah and plinth
total area = 130 sqm  
central core = 8.5 sqm  
cantilever = 22 sqm

living room = 25.5 sqm  
bedroom 1 = 12.3 sqm  
bedroom 2 = 12.3 sqm  
washroom = 7.5 sqm  
verandah = 31.5 sqm  
stairs = 8.5 sqm

inner living space = 44% total surface  
portico = 24% total floor surface  
walls in RCC and masonry = 12.8 sqm  
= 18.5% of the central core

inner living space = 44% total surface  
portico = 24% total floor surface  
walls in RCC and masonry = 11 sqm  
(= 16% of central core)
PUBLIC \ PRIVATE SPACES

- **Total Area**: 130 sqm
- **Central Core**: 8.5 sqm
- **Cantilever**: 22 sqm

- **Living Room**: 25.5 sqm
- **Bedroom 1**: 12.3 sqm
- **Bedroom 2**: 12.3 sqm
- **Washroom**: 7.5 sqm
- **Verandah**: 31.5 sqm
- **Stairs**: 8.5 sqm

- **Inner Living Space**: 44% Total Surface
- **Portico**: 24% Total Floor Surface

- **Walls in RCC and Masonry**: 12.8 sqm
  - 18.5% of the Central Core

- **U Value Roof**: 0.45 w/m²k (with fresh snow)
  - 4.0 w/m²k (only RCC)

- **U Value Wall**:
  - Bricks only: 2.0 w/m²k
  - Kiln dried bricks: 0.78 w/mk
  - Fresh snow: 0.06 w/mk
  - Compacted snow: 0.23 w/mk
  - 14 cm RCC: 1.16 w/mk
klin dried bricks = 0.78 w/mk
fresh snow = 0.06 w/mk
compacted snow = 0.23 w/mk
14 cm RCC = 1.16 w/mk

U value wall
2.0 w/m²/k (bricks only)

U value roof
0.45 w/m²/k (with fresh snow)
4.0 w/m²/k (only RCC)
ROOF COMPOSITION

- water tanks
- solar collectors
- half pilars / visible rebars for future extensions
- concrete slab / roof surface
- beams
- storage shelter

- gravel
- sand
- cement
- steel
- water
- 27.5 m³ gravel
- 14 m³ sand
- 10,400 kg cement
- 1545 kg steel
- 4140 litre water

10. B

solar collectors

beams

half pilars / visible rebars for future extensions

concrete slab / roof surface

storage shelter

water tanks
Cement (Coal fired dry processed)
Specific weight = 3150 Kg/m3
Emissions = 0.830 KgCO2 / Kg
Embodied energy = 4.60 Mj/Kg = 430 Mj/bag

Total amount = 57000 Kg
= 570 bags (100kg per bag)
Total Emissions of CO2 = 49600 Kg
Total Embodied Energy = 245100 Mj

Steel
Specific weight = 7860 Kg/m3
Emissions = 3 KgCO2/kg
Embodied energy = 33.33 MJ/Kg
= 262 MJ/m3

Total amount = 5910 Kg
Total Emissions of CO2 = 17730 Kg
Total Embodied Energy = 196980 Mj

Sand
Specific weight = 1450 Kg/m3
Emissions = 2.899 KgCO2/m3
Embodied energy = 0.0204 Mj/Kg
= 29.58 MJ/m3

Total amount = 75.6 m3 = 109620 Kg
Total Emissions of CO2 = 2236 Mj
Total Embodied Energy = 220 Kg
Total Embodied Energy = 2236 Mj

Gravel (aggregate)
Specific weight = 2690 Kg/m3
Emissions = 57.996 KgCO2/m3
Embodied energy = 0.220 MJ/Kg
= 591.8 MJ/m3

Total amount = 147 m3 = 395.5 Kg
Total Emissions of CO2 = 88500 Kg = 90 tons
Total Embodied Energy = 669500 Mj
Total Emissions of CO2 = 88500 Kg = 90 tons
Total Embodied Energy = 669500 Mj

EMBODIED ENERGY AND EMISSIONS

Kiln Fired Bricks
Measures = 22 x 10 x 7 cm - delivered at 150 Km
Emissions of CO2 = 202.255 Kg/m3
Embodied energy = 3.457 MJ/Kg = 2247.28 MJ/m3

Total amount = 40000 units = 61.5 m3
Total Emissions of CO2 = 12438 Kg
Total Embodied Energy = 138208 Mj
Total Emissions of CO2 = 12438 Kg
Total Embodied Energy = 138208 Mj

Total result and comparison (total volume = 281,5 m3)
Total Emissions of CO2 = 88500 Kg = 90 tons
Total Embodied Energy = 669500 Mj

urbanforestrynetwork.org:
10-year-old tree = -20 kgCO2/year
naturefund.de:
Average Petrol car = 2,32 KgCO2 x 12500 km
- 90000 kgCO2 = 90 trees per 50 years
+ 90000 kgCO2 = average car x 480.000 Km

10-year-old tree = -20 kgCO2/year
naturefund.de:
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