How to Adapt your House to Climate Change

Techniques and recommendations

geres
Energy
Environment
Solidarity

Climate Change

What is Climate Change?

Climate Change is usually referred to as "changes in the weather patterns over an extended period of time" that a given region experiences due to an increase in the Earth's average temperature. This can mean more or less precipitation, untimely snowfall, an increase in extreme weather events such as storms, floods and droughts, etc. Climate Change is caused due to an increase in the concentrations of Greenhouse Gases (GHGs like CO2, CH4, N2O, HFCs and SF6), which leads to an increased Greenhouse Effect.

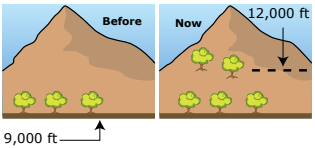
Impacts of Climate Change in the Western Indian Himalayas

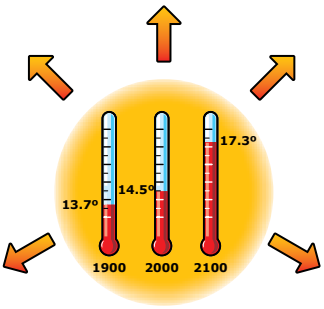
Glacier melting

1948 2006

Trift-Glacier, Switzerland

Shift in apple belt



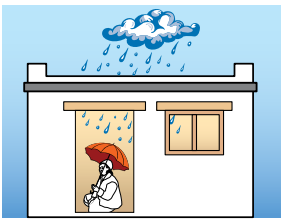


Shorter Chadar trek

Before	Nov	Dec	Jan	Feb	Mar	May
Now	Nov	Dec	Jan	Feb	Mar	May

More frequent floods

Changes in precipitation



Consequences on Housing

Heavier, more frequent and irregular rainfall	→	Water leakages from the roof and structure damage
High risk of floods	→	Structure damage (foundations, walls) until complete destruction

Roof waterproofing

Several efficient technical solutions exist in the Western Indian Himalayas to ensure a waterproof roof. Three of them, whose effectiveness facing heavy rainfall has already been proven and tested on the field, are described in the following pages:

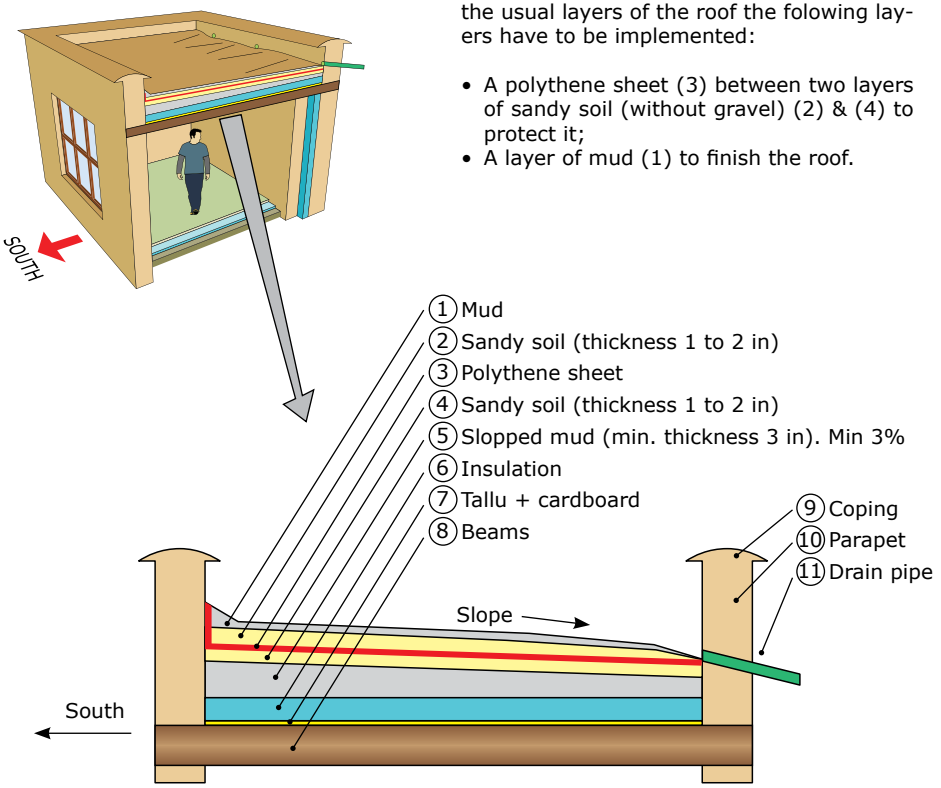
- Polythene sheet;
- Galvanized Iron (GI) sheet;
- Clay.

These technical solutions can be implemented in both new and retrofitted houses.

Polythene sheet waterproofing

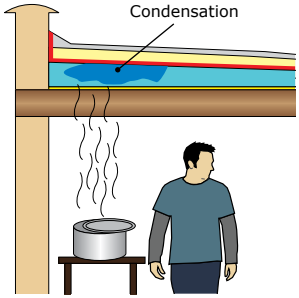
This solution uses a polythene sheet as waterproof layer for traditional flat roofs. Above the usual layers of the roof the folowing layers have to be implemented:

- A polythene sheet (3) between two layers of sandy soil (without gravel) (2) & (4) to protect it;
- A layer of mud (1) to finish the roof.



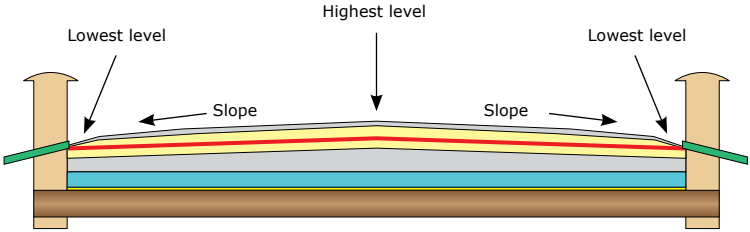
Advantages	Drawbacks
• Easy implementation • Affordable	• Risk of condensation within the roof for wet rooms (kitchen, bathroom,..) if layers of sandy soil (4) + mud (5) between insulator (6) and polythene sheet (3) are not implemented.

Avoid this solution for wet rooms (kitchen, bathroom) because of condensation risks. Water vapour created inside (by intense cooking for example) can get stuck to the plastic sheet and condensate within the roof. This could cause premature deterioration of the house structure (especially the insulator layer) and also degrade the indoor air quality.
If this solution is still chosen for a kitchen or bathroom, it is important to add a layer of sandy soil between the plastic sheet and the insulation layer to reduce condensation risks. Choose a waterproof insulator such as *yakzes* or *burtsey*.



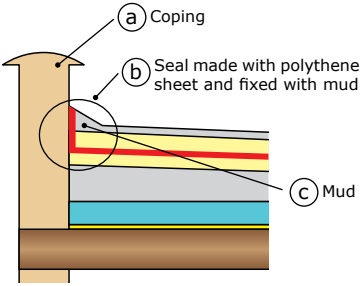
Slope of the roof

If the roof is large, having only one slope can cause overload on one side of the house. In this case, use the beams instead of the mud layer to create the slope, or distribute the slope in different directions as shown below (slope =minimum 3%).

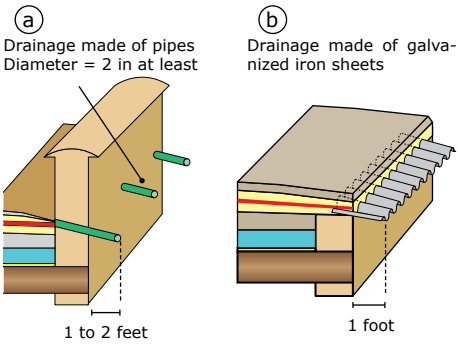


Other implementation key points

Corners between parapet and roof:
Join the corners between parapet and roof (b) with a layer of polythene sheet vertically along the parapets and fix it with mud (c). It is also advised to implement a sloped coping (a) on top of the parapet.



Drainage systems:
Install drainage systems to properly drain rain water. Without it, the risk of leakages is high. Two techniques can be implemented: drainage pipes (a) or galvanized iron sheets (b).



Maintenance

The roof should be checked at least once a year and after heavy rain. Particularly 3 points should be checked and fixed if needed: the waterproofing of corners (parapet/roof) and other singular parts (chimney…). The roof should remain sloped (minimum= 3%) and drainage systems should not be obstructed.

Main materials and cost estimate For a 30 ft x 30 ft roof

Material	Quantity	Cost estimation
Polythene sheet (1.20 gsm good quality)	950 sqft	4,275 INR
Plastic sheet transportation	-	Case to case
Skilled labor (to implement waterproof solution)	3 days	1,500 INR
Unskilled labor (to implement waterproof solution)	6 days	2,100 INR

NB: Prices based on Leh market 2011

Galvanized Iron sheet waterproofing

This technical solution consists of using Galvanized Iron (GI) sheet as a waterproof layer. Two techniques are widely implemented: GI sheet installed above beams of the roof (cf. photo 1) and GI sheet installed above local roof (cf. photo 2)

Photo 1

Photo 2

Advantages	Drawbacks
• Limited maintenance	• Can change the house outer aesthetic if GI sheet is very sloped • Very expensive

Maintenance

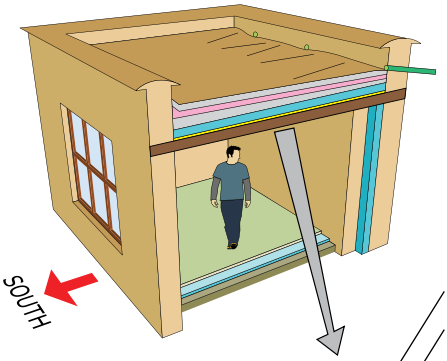
This type of roof doesn't need regular maintenance as other roofs but it is advised to check quickly the entire roof every year to prevent problems.

Main materials and cost estimate For a 30 ft x 30 ft roof using GI sheet above beams

Material	Quantity	Cost estimate
GI sheet (24 gauge = 0.51 mm)	45 pieces	45,400 INR
Wooden timber (safeda)	17.5 cft	7,200 INR
Nails and washers	-	1,100 INR
GI sheet transportation	-	Case to Case
Skilled labor (to implement waterproof solution)	6	3,000 INR
Unskilled labor (to implement waterproof solution)	15	5,250 INR

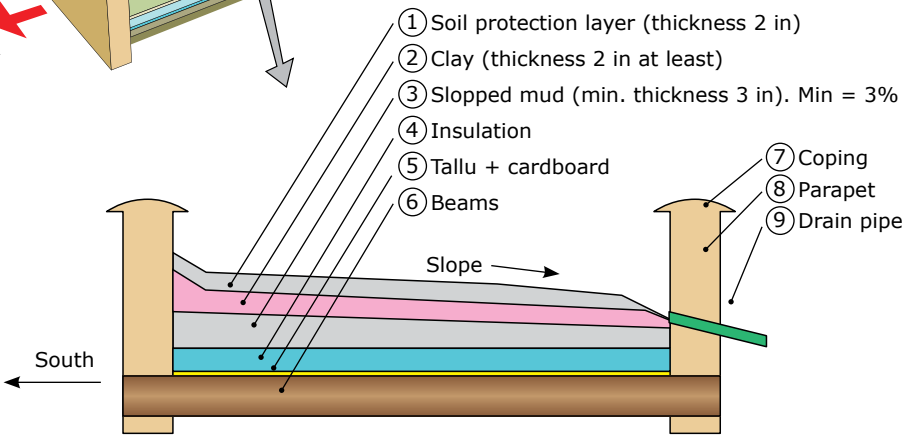
NB: Prices based on Leh market 2011

Clay waterproofing



This local solution uses clay as a waterproof layer for traditional flat roofs. The following layers are implemented above the existing roof:

A layer of clay (2) that plays the role of waterproof layer;
A layer of soil (1) that mostly plays the role of a protection layer for clay layer.

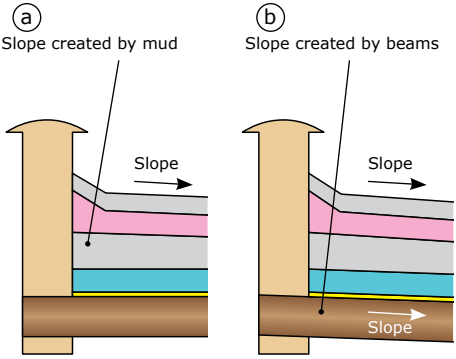


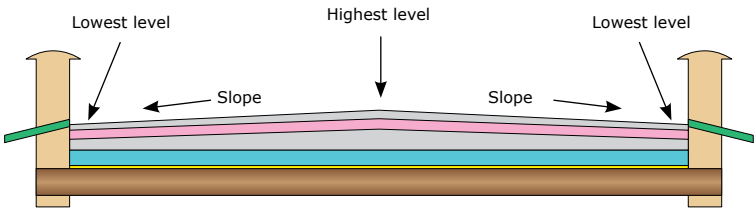
Advantages	Drawbacks
• Double function: - Protects against rainfall; - Allows water vapour to escape, decreasing condensation risks. • Affordable in most cases	• Regular maintenance required

Implementation key points

Layer of clay (2):
The thickness of the clay layer should be at least 2 inches. If good quality clay is not available, increase the thickness up to 3 or 4 inches. The clay should be crushed into small gravel and (if possible) mixed with yakzes (around 15% in volume) to bind/link it.

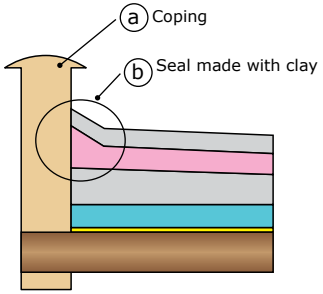
Slope of the roof:
The roof should have a proper slope (min = 3%) to drain the water. The slope can be created by the mud layer below clay (a). In case of overload on the thickest part of the roof, create the slope with beams (b) or distribute the slope in different directions (c).

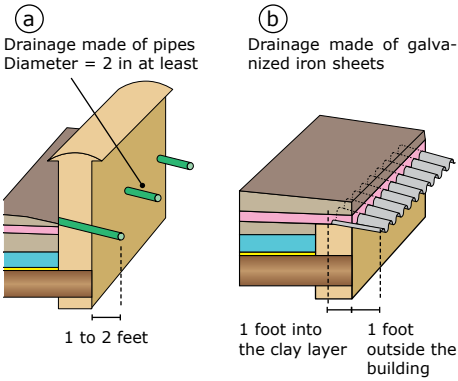




Corners between parapet and roof:
This part should be waterproofed by joining the corners between the parapet and roof (b) using clay and implementing a sloped coping (a) on top of the parapet. Another technique is to add a plastic sheet in the periphery of the roof to protect the corners from rainfall.

Drainage systems:
The roof should have a drainage system to properly drain the water. Two techniques can be implemented: drainage pipes (a) or Galvanized Iron GI sheets (b).





Maintenance

The roof should be checked at least once a year and after heavy rain. Particularly 4 points should be taken into consideration:
The corners (parapet/roof) and other singular parts (chimney…) should be checked and fixed if needed;
The roof should remain sloped (minimum 3%).
Drainage systems should not be obstructed;
The thickness of the soil (1) protection layer should remain 2 inches.

Main materials and cost estimate

For a 30 ft x 30 ft

Material	Quantity	Cost estimate
Clay 2 inches thickness	150 cft	Free in most of cases
Yakzes to mix with clay. 15% in volume	22 cft	1,000 INR *(free in most of cases)*
Clay transportation	-	Case to Case
Skilled labor (for implementation)	3-4	1,500 to 2,000 INR
Unskilled labor (for implementation)	6-8	2,100 to 2,800 INR

NB: Prices based on Leh market 2011

Recommendations for Flood-prone Areas

NB: These recommendations are standard advice (source: Traité de construction en terre—CRATERRE, 2006). When a recommendation is in conflict with Indian codes, the Indian codes shall take precedence.

Main principle

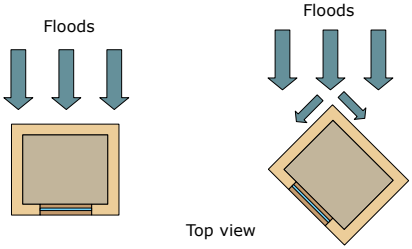
Do not build in flood-prone areas.

Surroundings

Reinforce surrounding fences and encircle the house with plants if possible to break the power of the wave.

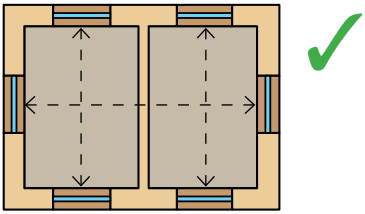
Remove heavy objects which could act as a battering ram.

Orient your house to reduce pressure of the floods' wave on the walls.



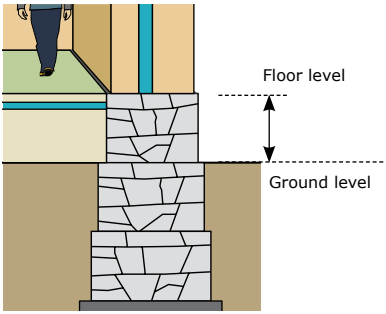
Doors and windows

Securely anchor doors and windows and place them in the middle of walls. You should also align doors and windows of opposite walls to avoid differential pressures.



Foundations

Build deep, solid and well anchored foundations. Foundations should be raised until the highest level of past floods in the local area. Choose good masonry and sustainable materials. Avoid foundations made of mud and do not use non-stabilized (without cement) mud as mortar.



Walls

Add strong lintels (like cement lintels) and reinforce the masonry. Partition walls should be heavy and connected to the main walls.

Floor and roof

Reduce the weight of floor and roof as much as possible to reduce danger of debris falling in case of collapsing. Plan openings on floors and roofs to help inhabitants to escape.

For further information contact:
LEDeG: Ladakh Ecological Development Group.
Tel.: 0091 1982 253 221. Mail: mail@ledeg.org

LEHO: Ladakh Environment and Health Organisation.
Tel.: 0091 1982 252 944
Mail: tashileho@yahoo.com

LNP: Leh Nutrition Project. Tel.: 0091 1982 252 151
Mail: lnpleh@yahoo.co.in

This publication is funded by the European Commission with cofunding from Fondation Ensemble, Fondation Abbé Pierre, ADEME, Fondation Lord Michelham of Hellingly, Crédit Coopératif, Synergie Solaire, Fondation MACIF, Gaz et Electricité de Grenoble and Fondation Legallais. The views expressed in this publication do not necessarily reflect the views of the European Commission and the partners.