Tools to support community transformation

C2 REVEALING GOOD PRACTICE

Flood-resistant buildings

At a glance

- This tool helps you make housing more resilient to flooding.
- Consider the options: what is the best approach for the community to take?
- Ensure lessons from the past are learned.
- Understand the local climate conditions.
- Ensure the right location is chosen.
- Ensure full participation of all the people who will be living in the housing.
- Choose the most appropriate designs, materials and building techniques (eg consider raised plinths, appropriate roof design, lightweight walls, reinforcing the joints of poles and beams, foundation columns, drainage, and sanitation).
- Consider access and evacuation routes.
- Consider how livelihood assets can be protected.
- What if mud is the only material available to build with?

Why use this tool?

This tool gives guidance on how housing can be made more resilient to flooding. It may be useful where housing has been damaged during flooding and people wish to rebuild their houses to be more resilient to future flooding – sometimes called 'building back better'. Or it may be useful for communities at risk of flooding where they want to make improvements to buildings that already exist.

Explaining the words we use

Plinth – the base or platform on which a building is built.
Hazard – an extreme event which could injure people or damage property and the environment.
Construction – the process of preparing for and forming buildings and building systems.

A brief description

There are many things to consider when building flood-resistant housing. This tool does not give step-by-step instructions on how to design and construct a flood resistant building, but rather highlights some of the key things to be aware of when trying to make buildings more flood-resistant in different contexts. It points to other resources which give more detailed technical instructions and advice.

Keys to success

- Consider sustainability and affordability options – building back the same and planning for future replacement is sometimes the most economic and locally acceptable option.
- Ensure the right location – can you avoid building in areas prone to flooding?
- Ensure lessons are learned from the past – help people to be prepared for future flooding.
- Understand the climate conditions – is flooding predicted by scientists to increase in this area?
- Ensure full community and stakeholder participation – so they input their knowledge and contribute to design and construction, and so that the finished houses are used and maintained.
- Ensure the needs of all people are considered in the design of buildings – particularly think about the needs of children, vulnerable adults and people with disabilities.
- Ensure appropriate building technologies and cultural acceptance of design and materials.

What to do

Before starting, consider the alternatives

Before deciding to 'build back better', it is important for a community to assess whether this is the most appropriate option for them. If the area you are working in has already flooded or is prone to future flooding, is there an alternative to building flood-resistant buildings? Can you relocate the buildings to a place that doesn't flood? This may form part of an advocacy project to help local people (see **Tool C1 - Advocacy: communicating with people in power**). If you can't do that, is it possible to divert the floods, or build the new buildings on elevated land, so you can avoid the additional cost and complexity of flood-proofing the structures? Related to this is the issue of **land tenure.** This is a common problem in many countries. If local people have few or no rights to own the land on which they live, then there is little incentive for them to have good quality buildings which once constructed could be taken away from them by the land owner.

Also, consider the **affordability** of different options. For example, it may be worth assessing the cost of repeatedly repairing existing houses, or even rebuilding earthen houses, compared to the cost of building a cement-based building which is resistant to floods. As long as there are accessible ways to ensure lives are saved and people's possessions are protected, then the community may want to consider which building solution is the most cost-effective. It's always possible that (if floods are infrequent and rebuilding is cheap) evacuating and rebuilding may be the most cost-effective approach. If this is so, it is important to think about how that process could be made more effective, and how the risk and cost to the women, men and children can be minimised.

Ensure lessons are learned from the past

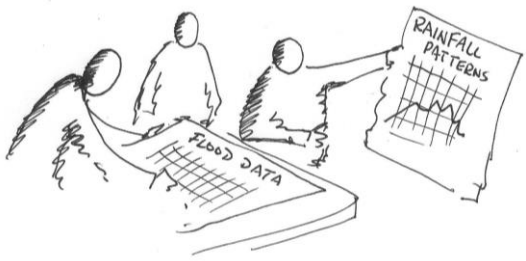
Ask questions such as:

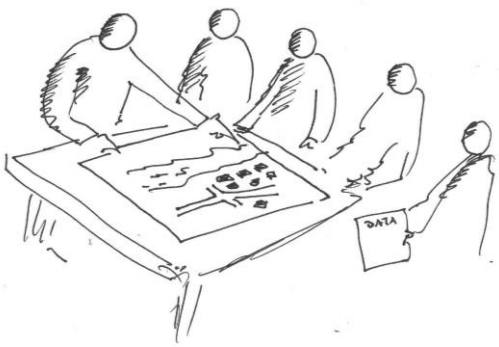
- Why have buildings failed in the past?
- What is it about the current buildings that makes them vulnerable to flooding? Was it poor construction techniques? Were low-quality materials used?
- Which existing houses survived the flood, and why?
- How can we learn about what works to lessen the impacts of flooding?
- How is learning recorded and accessed for future generations?
- Existing designs may have flood-resistant features which your work can replicate. However, it's important to be aware that sometimes houses survive due to unseen/hidden conditions such as the soil structure, better foundations, better reinforcement).
- What are the keys to minimise the impact of flooding on buildings in your local area?

Understand the local climate conditions

Find out about current and predicted local climate conditions. Ask questions such as:

- What is the local climate for the area? How is the climate changing? What hazards do and will houses have to survive (eg level of floodwater, wind speed of storms?)
- What are the locally appropriate techniques for building, given the climate?

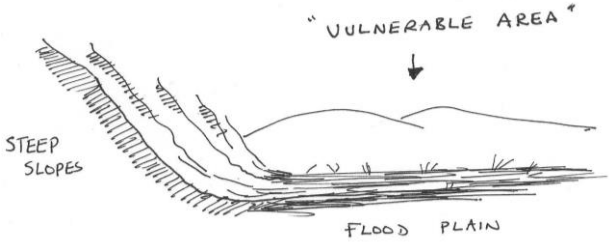




The community will be able to speak from their experience, but it is also important to consult scientific climate change information about future trends. Which local experts could you ask to advise the community on these questions? Flood maps are a useful tool to outline which areas are likely to be exposed to future floods, and to help people assess alternatives.

Ensure the right location is chosen

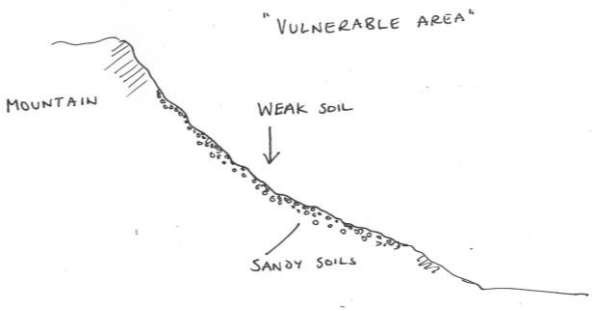
The following questions can help you with this:



- Why are people living in a flood-affected zone? Do they want to live there?
- Are there some people in the community who are forced to live on more flood-prone land?
- Are there other locations close by that are on higher ground? Would people be happy to move? If not, what obstacles are keeping people from moving voluntarily to a safer area? If people can move and are willing to, that can make a big difference.

Does the community you are working with own land, or are they informally settled? Do they own their houses, or are they renting? This can make a great difference in how much they are willing to invest in 'building back better'. Helping slum dwellers secure **land tenure** is one of the most fundamental ways to reduce their vulnerability to disasters.

- Could the houses be built on artificially raised higher ground?
- Could you build on raised plinths that are strong and high enough to last through repeated floods, unlike traditional earthen floors that simply wash away? Or could you build on raised stilts, for light wooden house construction? (See below for more information.)

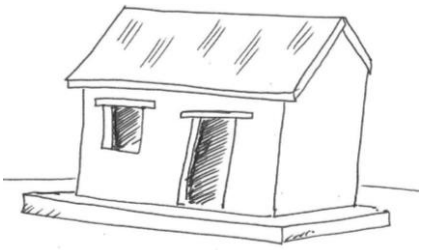


Ensure full participation of all the people who will be living in the housing

- How can you ensure the full participation of women, children, men and vulnerable adults in the planning, design and building of the housing? Ensure everybody's needs are considered. Think particularly about the needs of people with disabilities when thinking about the design.
- Are there people in the community who cannot rebuild their own houses? What support could be given to these people?
- Which materials do people use? What can they afford?
- Depending on the design, it is often best for people to **rebuild their own houses**, with the government and NGOs giving advice and paying for help from local carpenters and masons as needed.
- How do people usually add to their houses, for example building on extra rooms or upgrading from earth to brick or concrete? How can you make sure the design fits with that process?

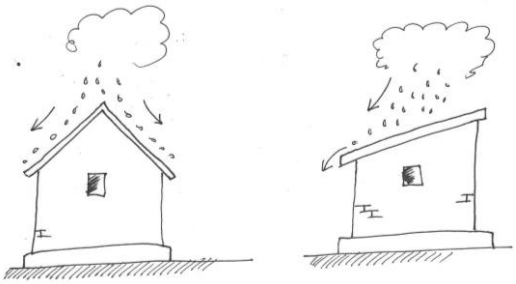
Choose the most appropriate designs, materials and building techniques

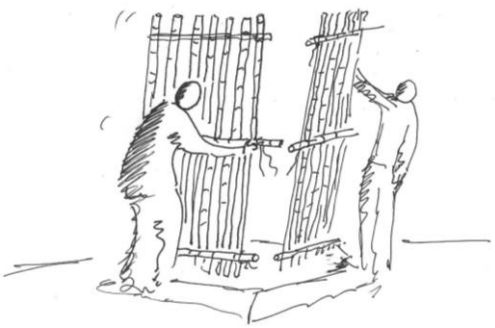
What traditional materials or techniques are available? While buildings need to be 'built back better', we need to ensure that local techniques and materials from local markets are used where possible. What **building standards** exist? Who can give you advice on this?



Could houses be built on **raised plinths** made from soil, a little cement and some pieces of stone and brick? These can be built strong and high enough to last through repeated floods, unlike traditional earthen floors that simply wash away.

What is the appropriate roof design? Roofs that slope either side of a central ridge (called 'gable roofs') split rain runoff (one half goes one way, the other half goes the other way), while roofs that slope from one side to the other direct all rain in one direction. Could **rain catchment systems** be built into roofs? These can reduce surface water rain runoff and may reduce small-scale flooding.

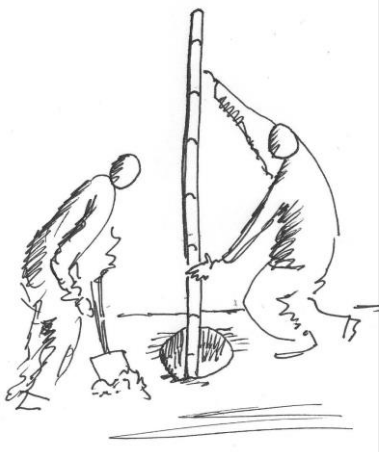




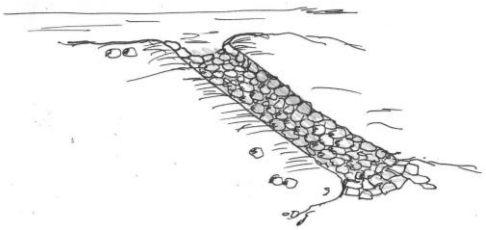
Could **lightweight walls** be built? In warm climates, bamboo and jute (or local equivalents) can make resilient walls that cost very little, are quick and easy to replace, and can be dismantled and carried to high ground if people receive warning of a major flood.

Could the **joints of wooden poles and beams be reinforced**? These are often a weak point. They can often be strengthened at relatively low expense with steel reinforcing braces, traction-resistant nails, metal tie rods and fastenings, and/or use of grooved joints. Are there local experts who could advise on this? There is more detailed advice in Tearfund's resource, *Disasters and the local church.*

Could **foundation columns** be added to buildings? A basic foundation of treated bamboo poles on concrete base columns can increase the chance of the roof structure (often the most valuable part of the house) remaining intact in a flood. For this to be effective, the columns must not rest on the plinth, but be sunk deep enough in the ground that they are not swept away by floodwater. There is more detailed advice in Tearfund's resource, *Disasters and the local church.*



How can **drainage** be designed so that floodwater does not become trapped? This is important to reduce the risk of water-borne diseases spreading during floods.



Are there needs for changes in **sanitation** at the household level and are these needs being met? How will sanitation facilities be flood-proof in the future?

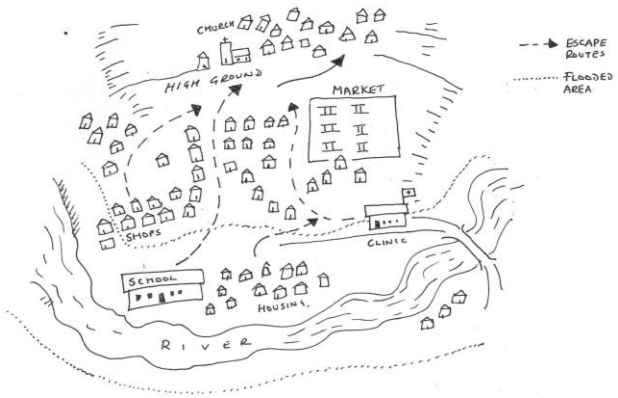
Could **water-thirsty plants** (eg bamboo or banana) and trees with deep root structures be set around the house to 'drink up' flood water and retain the soil?

When making **bricks for building**, be careful with clays or ‘expansive soils’. While they tend not to erode easily, they will ‘swell’ and cause destruction to homes, and clay embankments/barriers tend to fail without warning.

Testing soil for clay content
A basic test is to roll the soil into a length approximately the size of an earthworm. If it crumbles, it's mainly sand; if it snaps, it has some clay content; if it holds its shape when bent, it has high clay content.

Consider access and evacuation routes

When rebuilding**, how can people’s access routes be protected?** For example, to transport links, water, sanitation, health and education services, and livelihood resources (eg land, water, markets)? Are there evacuation routes (ideally, more than one route option)? Could **access ways** to houses be elevated so they remain safe and dry? When planning access, always remember to consider all vulnerable groups.



Consider how livelihood assets can be protected

Could houses and compounds be designed with safe spaces for key livelihood assets, such as small livestock, tools and valuables, so they are not swept away by floodwater? For example, building a platform inside the house where crops and tools can be stored, or designing a henhouse so that it can be easily picked up and carried to safety.

But what if mud is the only material available to build with?

If mud is the only material the community has to build with, there are still steps that take be taken to make the houses more flood-resilient, although some of these may not be possible due to cultural or financial restrictions.

- Could the roof overhang (the 'eave') be extended further out, past the walls? This won't fully address wind-driven rain, but should keep some of the rain off the walls
- Can you mix the mud with straw or animal hair to strengthen it?
- Could oil or turpentine be added to the finishing slurry to help make the walls water-'phobic' (causing moisture to bead up and roll off)?
- Could the exterior walls be finished with a 'slurry' (loose mud liquid) of mud and cow dung?
- Could soil-stabilised bricks be used? (See below)

Identifying soil which can be stabilised by cement

Mixing a small amount of ordinary Portland cement to earth greatly increases its resistance to water. This process is known as 'stabilisation'. Stabilisation works best if the earth is also compacted.

Cement stabilisation is suitable for soil that has very low or no organic content, and low clay content. You can tell if this is the case if the soil has larger sandy particles in it. Soil with less than 40 per cent sand content cannot be properly compacted and stabilised. If this is the case, sand has to be added to the soil. Soil with more than 40 per cent sand content can generally be stabilised with five per cent cement by volume.

Here is one method of identifying the type of soil:

- A see-through jar with 20 centimetres marked individually up the side should be filled with soil to 5cm high.
- Water is then added up to the 20cm mark.
- The jar is then sealed and shaken thoroughly.
- After that, it should for kept still for one hour, then shaken again and left to settle.
- 45 minutes later, the height of each layer (gravel, sand and silt) can be measured.
- 8 hours later, the height of sedimented clay should be noted.

If there is more than 1 cm of clay or less than 2 cm of sand, more sand should be added to the soil mix. This test can then be carried out again until enough sand is present in the soil.

Ideal stabilisation soil	
Particle type	**%**
Fine gravel (2-4mm)	7
Sand	53
Silt	20
Clay	20

SOURCE: adapted from Asian Disaster Preparedness Centre (2005) Handbook on design and construction of housing for flood-prone rural areas of Bangladesh

Finding out more

- Tearfund (2012) Climate Change and Environmental Degradation Risk and adaptation Assessment (CEDRA) www.tearfund.org/CEDRA
- Tearfund (2011) *Disasters and the local church* http://tilz.tearfund.org/en/themes/disasters/disasters_and_the_local_church/
- Practical Action brief on *Flood Resistant Housing* http://practicalaction.org/flood-resistant-housing-7
- Asian Disaster Preparedness Centre (2005) *Handbook on design and construction of housing for flood-prone rural areas of Bangladesh* http://www.adpc.net/audmp/library/housinghandbook/handbook_complete-b.pdf

Related tools

- A1 – Revealing fatalistic beliefs about disasters: information for facilitators *[A1: Disaster risk management-1]*
- A2 – The need to prepare – reducing the effects of disasters *[A2: Disaster risk management-1]*
- A2 – Disasters ball game - understanding shocks and stresses *[A2: Disaster risk management-2]*
- B – Fatalism: can we avoid disasters? (Bible study) *[B: Disaster risk management-1]*
- B – Noah - lessons in preparedness (Bible study) *[B: Disaster risk management-2]*
- B – Preparing for disaster (Bible study) *[B: Disaster risk management-3]*
- B – God of justice and mercy (Bible study) *[B: Disaster risk management-4]*
- B – God's provision for the future (Bible study) *[B: Disaster risk management-5]*