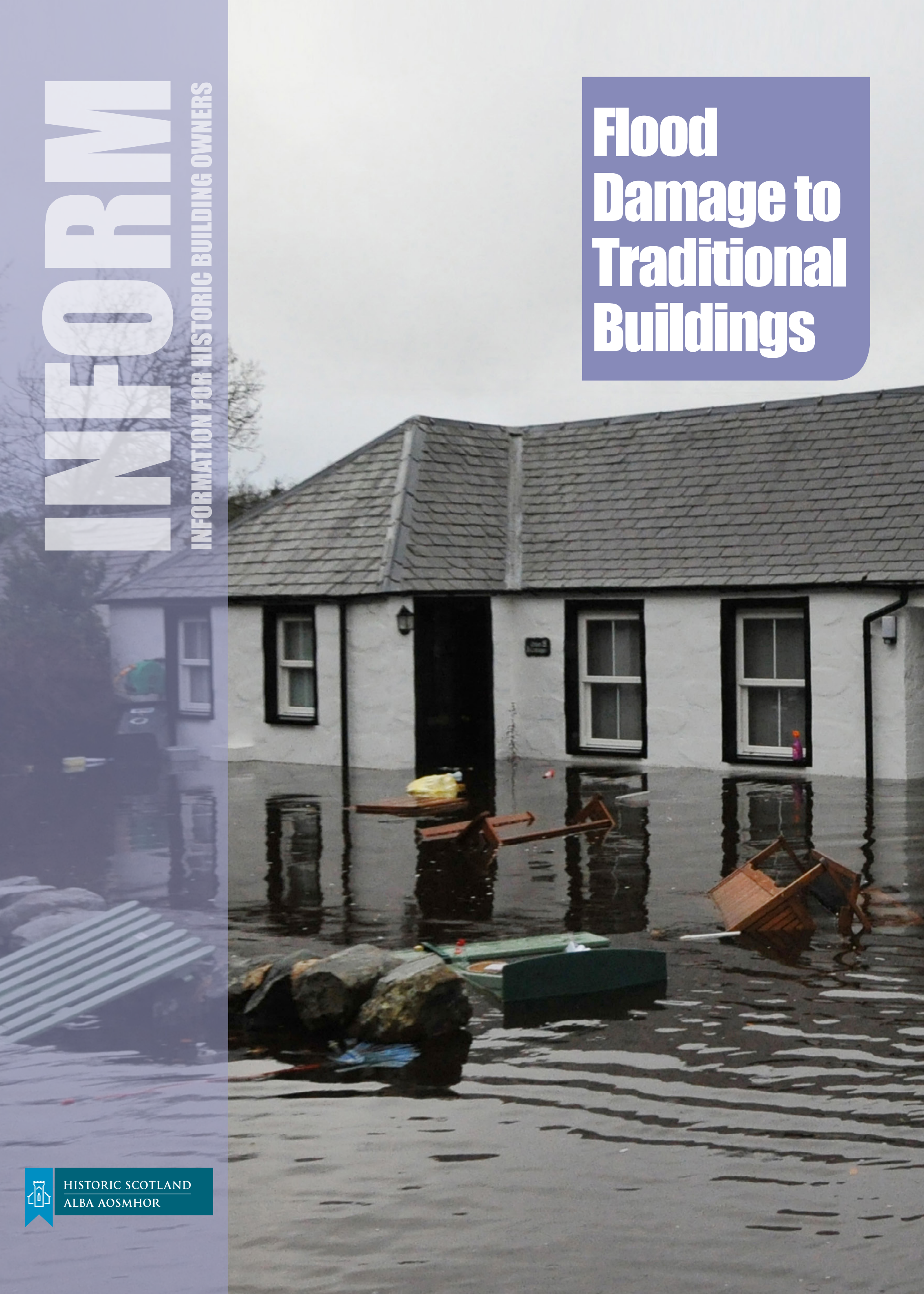
INFORM

INFORMATION FOR HISTORIC BUILDING OWNERS

Flood Damage to Traditional Buildings



HISTORIC SCOTLAND
ALBA AOSMHOR

Introduction

Some areas of Scotland have always suffered from periodic flooding as part of natural weather events and as a consequence of land use, but in recent years the frequency and scale of flood events has increased (Fig. 1).

Predictions for climate change indicate that the frequency and severity of flood events throughout Scotland are likely to get worse over the coming years.

This INFORM offers guidance on how to protect traditional buildings from flood damage, and how to mitigate the effects if flooding does occur.

Flood risk

The location of many historic settlements in coastal areas and close to rivers can make them vulnerable to flooding. Changes in weather patterns and land management, and factors such as the increase in hard surfacing around domestic properties can increase the risk of flooding. Traditionally constructed buildings are no more vulnerable to the effects of flooding than other buildings. In some cases they have more natural resilience to water damage than modern structures built using composite materials, as traditional buildings are often constructed from naturally permeable and flexible materials which can tolerate a certain amount of heavy wetting and drying. However, methods of flood mitigation for older buildings require careful consideration, as elements such as timber floorboards, panelling and plasterwork can be affected by flooding and are sometimes damaged or removed during the clean-up phase.

Fig. 1 *The frequency and scale of flood events is increasing (© Paul Hendy).*

Fig. 2 *Flooding caused by blockage in surface water drainage system (© M. Kay).*

Fig. 3 *Floodwater can contain contaminants and debris (© Paul Hendy).*

Sources of flooding

Flooding can occur from rivers and the sea, from direct rainfall, rising groundwater, or surface run-off from higher ground. Flooding often occurs after heavy and sustained rainfall when the ground becomes saturated. This can be compounded if rivers burst their banks, overloaded local drainage systems back up and overflow (Fig. 2), or where run-off is focussed on built up areas. Localised flooding can also be caused by burst water mains, defective drains or other plumbing failure, although this tends to be less catastrophic. This INFORM does not deal specifically with water damage following a fire or localised plumbing failure, but many of the same principles of repair will apply.

Effect of floodwater on buildings

Floodwater can rapidly penetrate buildings and can cause damage to structural elements such as walls and floors, and to finishes including plasterwork, skirting boards and panelling. Poorly maintained buildings are particularly vulnerable as water will find its way through weak points within the external envelope such as defective or decayed materials, cracks in masonry, gaps under doors and around ill-fitting windows, and gaps at entry points of services. Even in well maintained buildings water can penetrate through airbricks, vents and gaps in floors, via backed-up drainage and sewage systems, through joints in brick or stonework and, under pressure, directly through porous materials such as brick or stone. In extreme cases structural damage can occur.

The high permeability of many natural and traditional building materials can be an advantage once the flood water has subsided, as the materials are able to dry out. However, organic materials will be more susceptible to rot if they are left in a damp condition for extended periods. Traditional materials are sometimes expensive to replace and therefore their retention and repair is generally desirable.

Floodwater can contain contaminants from drainage and sewage systems, or from surface run-off. Dealing with the consequences of contaminated flood water is often a significant part of the clean-up and repair process (Fig. 3). Information about dealing with contaminated water is available from the Scottish Flood Forum (see contacts).

Timber

Timber is found widely in traditional buildings, and unlike that used in modern construction, is often untreated. Most wood will expand and deform or warp when wet, but will typically recover its original form on drying. Tongue and groove flooring and wall panelling can be damaged by expansion during saturation, but plain edged boards, solid wood doors, panelling and timber window and door frames will often return to their original shape, and can be repaired and redecorated. This compares favourably with modern composite doors which often have cores that absorb water and are slow to dry, or modern chipboard, ply board or particle board materials which are highly absorbent and can disintegrate when saturated. Laminate flooring tends to warp and separate irreversibly.

Damage to timber elements can be caused by the after effects of saturation as well as the flood event itself. Timber with a moisture content of above 20% is susceptible to fungal attack and the longer the timber remains wet, the higher the risk of an outbreak of rot. Therefore the priority must be to remove standing water and adequately dry the structure. Drying too rapidly, on the other hand, can cause warping and splitting of timber, so a measured approach must be taken ideally using dehumidifiers and axial fans to circulate the air.

Masonry

Porous building materials such as some brick and sandstone, particularly with rubble infill, can absorb large quantities of water and take months to dry out, especially if the external skin of the wall has denser masonry or impervious coatings. Denser types of natural stone such as granite or whin absorb very little water and tend to be less vulnerable, although where water ingress occurs, the structure can be at risk from prolonged wetting. Masonry and concrete are unlikely to be severely damaged by flooding, although salt damage from coastal flooding can cause surface powdering and flaking of soft stone. If the flood water reaches a depth of one metre or more, or where it is fast flowing, there is a risk of structural damage to masonry (Fig. 4).

Once the flood waters have receded, the presence of excess moisture can cause disruption

Fig. 4 *Fast flowing or deep water can cause structural damage (© Paul Hendy).*

to internal wall surfaces from staining and can increase the risk of damage to external walling through salt crystallisation and frost action. Internal walls can also show salt efflorescence as the wall dries out. This can often simply be brushed off once dry, prior to redecoration. This process may have to be repeated if salts remain within the wall core. Water or cleaning products should not be used where salts are present.

Plaster and render

Plasterwork is particularly susceptible to water damage. Soft lime based plasters (often found in traditional buildings) generally remain intact, and although they can soften when wet, will normally recover on drying. They tend to be more resilient than gypsum plasters, which will tend to crumble or even disintegrate when wet. Gypsum plasterboard can rarely be salvaged from flood damaged buildings. Plasterboard may have insulation behind, which will absorb moisture and will need to be removed. The main risk to internal finishes is from mould growth on surfaces which remain damp or contaminated after the flood event. Internal surfaces should be thoroughly washed down using clean water and a suitable disinfectant to inhibit mould and bacterial growth. Lime and horse hair plasters carry a small potential risk of anthrax so precautions should be taken if the plaster has become friable or disintegrated.

Fig. 5 *Temporary air brick covers (© Paul Hendy).*

Fig. 6 *Temporary flood barriers can be easily fitted into permanently fixed frames when required (© Paul Hendy).*

External cement based renders are unlikely to be damaged by floodwater, but their presence will hinder the drying out of the wall core as they are impermeable to moisture. Lime mortars and harls can sometimes become friable following saturation especially if they are exposed to frost, however in many cases they will dry out and require only minor repairs. Staining may appear on the external surfaces of lime-harled buildings as the wall core dries out. Modern external paints can inhibit drying and may blister and peel following saturation. Repainting with limewash or mineral paint may be desirable.

Interior decoration

In most cases, redecoration will be required following flooding. Old lining paper and wallpaper may need to be removed to facilitate drying or where it has been affected by contaminated water. Old wallpaper paste can support mould growth and should be washed off with sugar soap. Vinyl wallpapers inhibit drying and should be removed following flooding. Traditional paint finishes 'on the hard' such as limewash or clay paint are very vapour permeable and will not impede drying, although soft distemper does not cope well with moisture and can flake off and become mouldy in damp conditions. Where an interior is of particular historic interest, for example where there is historic wallpaper, wall paintings or fabric wall coverings, it can sometimes be retained with careful treatment. Historic fabrics will need professional attention. In cases where historic interiors are damaged, a specialist conservator should be consulted.

Flood prevention measures

There are many products on the market which can be used to temporarily protect a building against flood events. Sandbags are the most basic, but more specialised products include air-brick covers which simply clip into place (Fig. 5), and plastic or metal boards used to seal openings such as doors and windows. These barriers typically slide into a frame which is permanently fixed to the openings (Fig. 6). On a larger scale, 'flood skirts' are wrapped around the walls of buildings to prevent water seeping through porous materials.

Barriers can be fixed at a distance from a property to hold back water or divert it away from the building, however these will not prevent seepage of groundwater to the foundations, cellar or basement or prevent backflow through overloaded drains (Fig. 7). Backflow can be prevented by fitting non-return valves and bungs to drainage systems and by sealing plugholes and toilet bowls. These measures all require adequate warning if they are to be effective. Maintenance of drainage around the property is important; drainage systems should be regularly checked to ensure they are not defective or obstructed.

***Fig. 7** Perimeter flood barriers can keep water away from a property.*

The installation of sump pumps in basements and solums at risk of flooding should be considered. The Scottish Flood Forum provides a free independent flood protection survey and keeps a store of sample products.

Flood proofing

Replacing elements such as timber doors or floorboards with waterproof alternatives (e.g. plastic and concrete) after a flood event, or to mitigate the risk of damage from future flooding, is not advisable for traditional buildings, particularly if they are of historic interest. Such an approach is likely to result in a considerable loss of original materials and features and can actually make drying out more difficult. Where there is a risk of future flooding some anticipatory adaptation may be advisable including reinstatement of vapour permeable finishes, (e.g. replacing damaged gypsum plaster with lime plaster) or reinstating wiring, sockets and switches above anticipated flood level.

Water resistant coatings which seal up the external envelope and help retard the penetration of water through the building envelope are not generally recommended. They are often bituminous or tarry in formulation and are extremely difficult to remove once applied to brickwork or stone. Tanking of walls and basements can sometimes lead to their full-scale failure in a severe flood due to the high pressure exerted on the walls. Similarly, impervious paint finishes, applied membranes and cementitious renders should be avoided as they can slow the drying process.

Drying out

The longer a building remains wet or damp following a flood event, the greater the risk of fungal and insect attack to timber and the degradation of building materials and finishes. There are essentially three main approaches to drying out a building: natural ventilation, convection drying (heating), and dehumidification. Assisted drying is a specialised form of heating and dehumidification.

Natural ventilation

Opening doors, windows and vents to allow air to circulate and promote evaporation of moisture is the simplest method of drying and may be all that is required where water penetration has been limited. Natural drying is a slow process and if air is not continually refreshed, mould can form on damp surfaces. Fans can be used to encourage air movement. During the warmer months of the year, and during dry mild weather, natural ventilation can be effective, but during the winter months when external humidity is high and temperatures low, it is unlikely to be sufficient.

Convection drying (heating)

Heating the building fabric will increase the rate of evaporation of surface moisture. Supplementing natural ventilation with heating to increase the rate of evaporation is a common method of drying, but this is only effective where fresh, dry air can be circulated. Some opening up may be required to enable drying, such as lifting floorboards or temporarily removing panelling, but stripping out is not required. Without careful supervision opening up can cause damage or result in material being unnecessarily discarded.

Dehumidification

Dehumidification (using desiccant or refrigerant dehumidifiers) is usually a faster method of drying out, and requires the doors and windows to be kept closed. Refrigerant dehumidifiers will not work below 5°C, and therefore in Scotland desiccant dehumidifiers are more suitable in the winter months. Dehumidification removes moisture from the air and consequently raises the air temperature, which in turn promotes drying. It works best when the flood-affected areas can be isolated and is more effective if the room temperature is elevated using background heating (Fig. 8). Dehumidification is likely to be the most appropriate option during winter floods where more rapid drying is required and ventilation is less feasible. Rapid dehumidification can cause warping or splitting of timber, as the surface dries out more rapidly than the core. However, for most situations, the risk of some damage to timber or plasterwork from differential drying is less than the potential risk of fungal growth and timber decay due to prolonged dampness.

Fig. 8 *Conventional heating and dehumidification.*

Assisted drying

More sophisticated proprietary methods of dehumidification combined with convection drying are available which typically involve sealing the building and pumping in very dry air, simultaneously drawing out the moisture-laden air. Access holes can be drilled to allow access to cavities (behind lath and plaster, under floors, or behind timber panelling) which allows the moisture to be drawn out. This can be used for a whole building, or targeted to areas where moisture is trapped. It is a very rapid and effective method of drying and requires minimal disruption to internal linings and finishes. Again there is a risk of damage, such as splitting or warping of timber elements, but these can normally be repaired. The risks must be balanced against the advantages; namely the greater retention of building fabric, and enabling the building to be reoccupied much more quickly than conventional drying methods.

Monitoring

With all methods, it can be helpful to monitor the drying process. The moisture content of materials can be measured using damp meters, microwave moisture meters or temperature and humidity probes. Conventional damp meters will often only measure surface moisture levels and readings can be affected by salts or the presence of metal elements. Longer term monitoring can be carried out using temperature and humidity data loggers. Thermal imaging and microwave moisture meters are quick, non-invasive methods of identifying damp areas and can assess moisture levels within the wall core. Spaces behind voids can be visually inspected with boroscopes if necessary.

Conclusion

Flood damage can be prevented or mitigated by taking precautions to protect a building prior to a flood, although in many situations some water ingress cannot be avoided. Traditional buildings can be resilient to flood damage, and can often recover with appropriate treatment. However the longer a building remains damp, the more likely the risk of further deterioration and loss of fabric. The repair of flood damaged buildings is a specialist sector with advice and new technologies continually evolving. A balanced approach should be taken to drying, accepting that some damage to materials may result from using rapid drying techniques.

Further reading and contacts

Historic Scotland Conservation (technical advice)
T: 0131 668 8668
E: hs.conservationgroup@scotland.gsi.gov.uk
W: www.historic-scotland.gov.uk/conservation

The Scottish Flood Forum
Caledonian Exchange
19A Canning Street, Edinburgh EH3 8HE
T: 24hr enquiry line: 01698 839021
W: www.scottishfloodforum.org

The Scottish Environment Protection Agency (SEPA)
SEPA provides advice on flood preparation and flood risk
W: www.sepa.org.uk
T: SEPA Flood line: 0845 988 1188

BSi PAS 64:2013 Mitigation and recovery of water damaged buildings – code of practice

DCLG (2010) Guidance and standards for drying flood damaged buildings
Signposting current guidance – BD2760

INFORM – *Damp: causes and solutions*, Historic Scotland, 2007

INFORM – *Rot in timber*, Historic Scotland, 2008

Historic Scotland's INFORM Guide and Short Guide series contain further information on the conservation and maintenance of traditional buildings. These publications are free and available from our technical conservation website, address above. Alternatively, you can contact us on hs.cgpublications@scotland.gsi.gov.uk for these or any other publication enquiries.

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