FLOOD BARRIERS – AN ADAPTATION MEASURE TO CLIMATE CHANGE

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Abstract

Flood Resilience (FRe) Technology is a tool that reduces the risk of flooding in built up areas and especially at a local (property) level. This technology is compatible with the EU policy "Living with the Floods", whereby the increased flood hazard is recognized and the built environment is adapted to this new environment.

Many products are available in the market targeted and satisfying various applications. Flood Resilience (FRe) technology is a promising tool for areas exposed to flood hazards (fluvial, pluvial, coastal etc) and with increased risk of damage (loss of life, property, disruption of operations).

Keywords

Flood, Barriers, Adaptation, Resilience, Technology

Flood Hazard

Precipitation, waves, land use, population growth and value of goods at risk in flood prone areas are some the parameters which affect the risk of flooding. Climate change has a direct impact on some of these parameters and hence on flood risk.

- Precipitation is becoming more extreme and more frequent, thus rainfall intensity increases.
- Sea level rises, wave heights become higher and more frequent causing more wave overtopping and hence coastal flooding.

Precipitation

Increased temperatures accelerate the rotation of the water cycle (figure 1) and enhance the temporal and special variability of rainfall intensity. Flooding due to preciptation is associated with the intensity and duration of rainfall. Flash floods, which is the most cause of flooding in Cyprus is the result of intense rainfall over a short period of time over a catchment area. The intensity of rainfall is expected to be increasing with increasing temperatures and flash floods becoming more severe and more frequent.

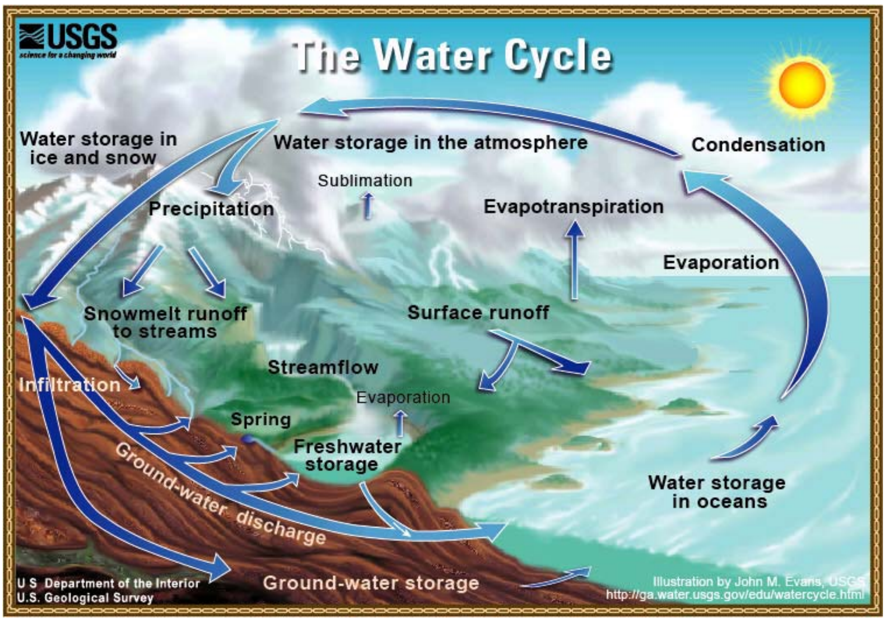

Figure 1. The water cycle (USGS)

Coastal Flooding

Increased temperatures of the atmosphere and of sea water are associated with higher sea levels. For the same wave conditions, wave run-up (figure 2) reaches higher elevations.

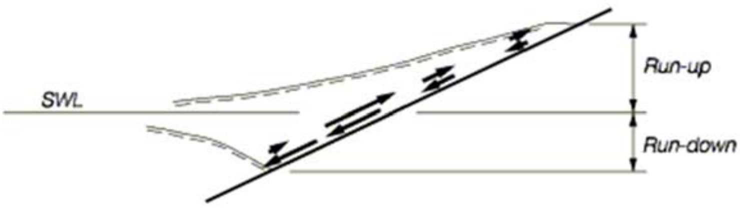

Figure 2. Wave run-up definition

Wave breaking in coastal areas is associated with the water depth. The wave height is depth limited in many coastal areas, the maximum wave height being about 0.78 times the water depth. For the same location the maximum wave height becomes higher for higher sea levels.

Climate change is causing more intense and more frequent storms and hence higher and more frequent extreme wave heights. For the same sea level storms will be producing higher wave run-up.

Higher sea level coupled with higher wave heights result in higher wave run-up (figure 3). Coastal areas which presently experience wave overtopping and flooding will experience more intense and more frequent coastal flooding.

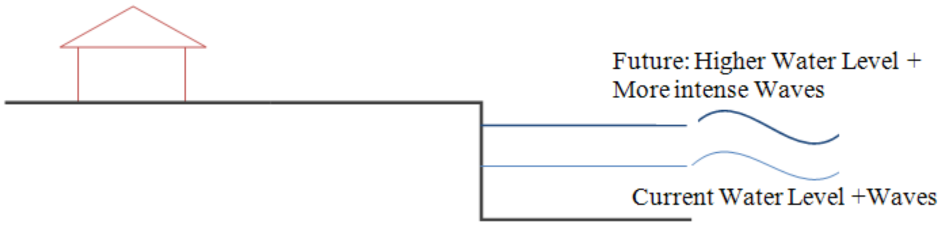

Figure 3. Coastal flooding becomes more extreme and more frequent.

Flood Risk

The damage caused by flooding may be reduced by measures such as:

- Increasing the capacity of the drainage systems
- Relocating the vulnerable properties and uses away from the flood prone areas
- Raising the properties to higher level
- Raising walls/ barriers when there is a flood hazard

All the above measures, and many more, are technically feasible ones and are being used in various cases.

Drainage Systems with Adequate Capacity

The traditional method has been the construction of underground drainage networks which collect surface water run-off and transport it to suitable receptors such as streams, rivers, lakes, seas, oceans.

More recent measures are SUDS, Sustainable Urban Drainage Systems, (figure 4) which delay and retain surface run-off. The main aim of SUDS is to spread the time over which water flows away from a property to a drainage network, thus reducing the flow rate and the risk of flooding.

In all cases these systems are designed for finite probability of exceedance. Typical probabilities of exceedance in any one year are about 1 in 5 (20%) for commercial areas (EN 752). Over a period of say 20 years most areas will most probably be flooded.

Figure 4. Permeable pavements – A SUDS measure

Relocation Away from Flood Prone Areas

Building in flood plains or close to the coastline was avoided in earlier times. Cyprus, a small island, had very few villages next to the coastline. Communities next to harbours which grew into cities were mostly built at high levels, away from the coastline.

Relocating far from the flood prone areas has many economical and social problems. The passage of time has turned many of these areas into historical, archaeological sites which are to be preserved.

Relocation is generally not a feasible option.

Raising of Properties to Higher Levels

This is a technically possible option. Raising existing structures and infrastructure is an expensive task and it is not financially feasible. However, planning now for future raising of the ground level is both technically and financially possible and feasible. Building new structures so that the ground floors have high ceilings, the doors and windows make provision for future raising of the road level is an adaptation measure that may be implemented. This measure is most appropriate for coastal areas at low level.

Flood Barriers

Flood risk is an intermittent one. The occurrence of flooding may be forecasted or at worst flooding gives a short warning which depends on the speed of its propagation.

Technology is currently being introduced to block flood water from damaging properties and risking life.

Barrier Technology

Flood barriers may be used to protect large areas, such the Thames Barrier (Figure 5) protecting London and Moses (Figure 6) protecting Venice from storm surge flooding.

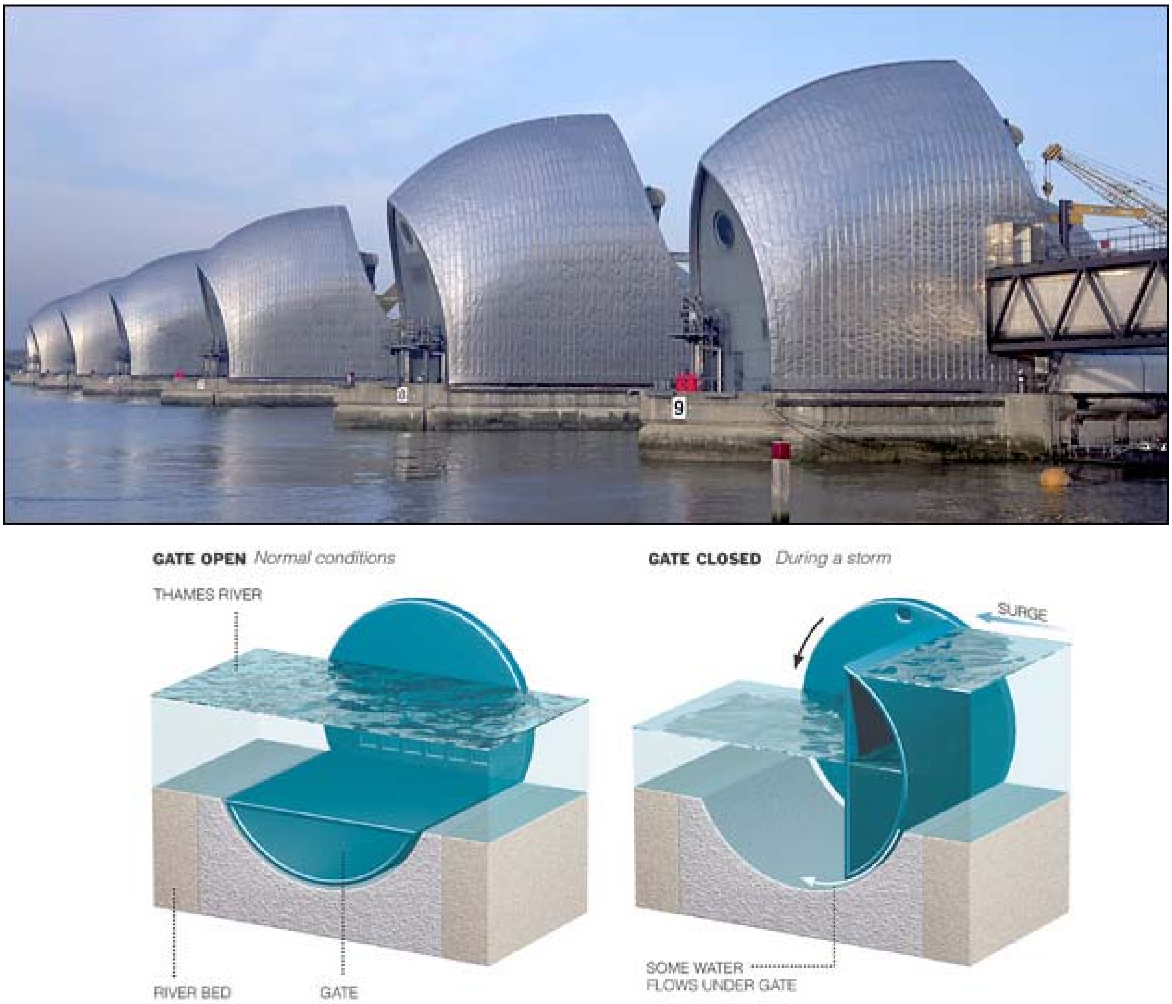

Figure 5. Thames Barrier

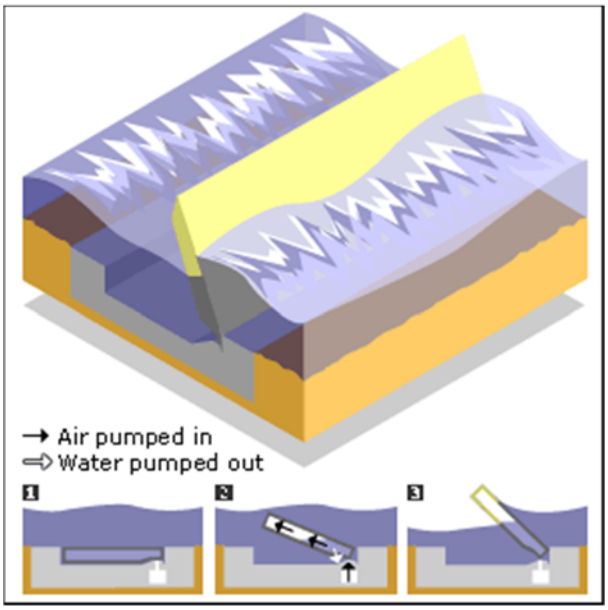

Figure 6. Venice, Moses Project

New York city is considering the construction of a similar flood barrier project after Hurricane Sandy caused significant flood damage in October 2012.

At smaller scale flood barrier technology has been available for a number of years (Gravin 2012). Within the FP7 EU funded project SMARTeST (Smart Resilience Technology, Systems and Tools) a database of available technology was compiled. There are for example products protecting the perimeter of properties which are pre-installed and are deployed prior to the flood (figure 7), or products which are temporary ones and are transported and mounted at the flood prone areas (figure 8).

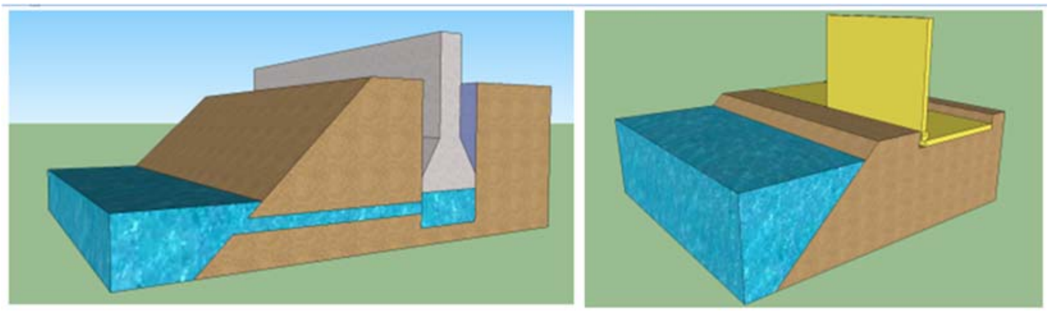

Figure 7: Pre-installed Flood barriers. Left automatically operated using buoyancy forces; right mechanically or manually erected products (sketches Gabalda)

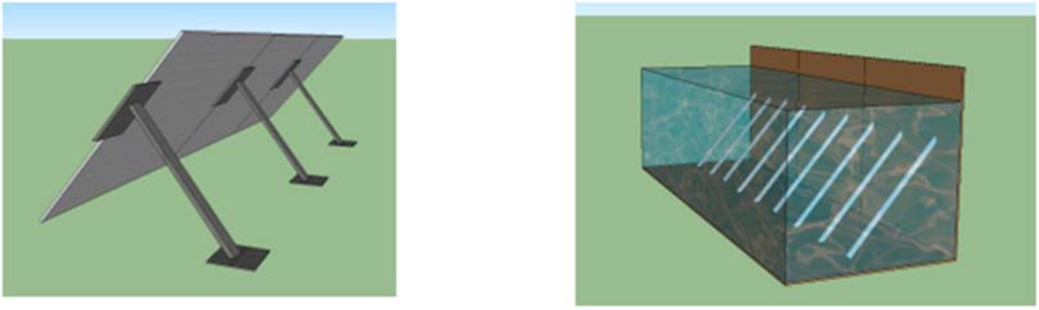

Figure 8 Temporary Perimeter Flood Barriers stablized by external forces. Left Trestle products; Right Set –square product (sketches Gabalda)

There are also products which protect the openings/ apertures of properties, like doors, services, air bricks, etc (figure 9).

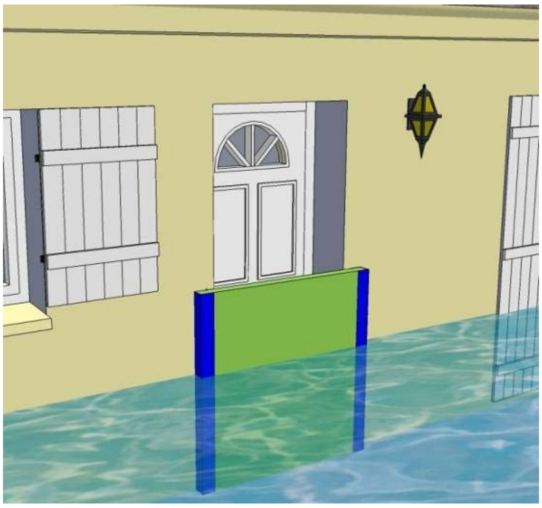

Figure 9: Demountable building aperture flood barriers.

All these products are supplied by specialist manufacturers. There is a continuous entry of new and improved flood barriers.

Passive Barriers

An example of a passive barrier is the patented (U.S. Pat.No. 2011/0110722 A1, May 12, 2011) Self Closing Flood Barrier (SCFB™) (figure 10) in which, a vertical dam is forced upwards out of a chamber whenever the chamber fills up with water. The dam is normally underground and invisible for the environment.

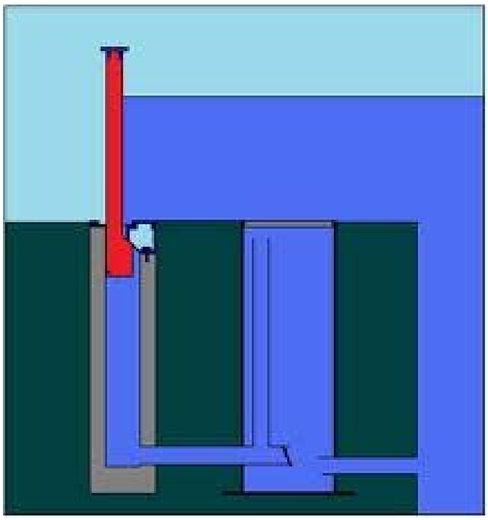

Figure 10: Self Closing Flood Barrier (SCFB)™

An example of a passive flip-up barrier the patented Flood Break ® (US patent no. 6,623,209 B1, Sep 23, 2003). This product includes a horizontally pivoted flood gate which is floated out of a housing in the ground due to water pressure bounded by the rising gate and two side walls.

Figure 11: Passive Flood Barrier Floodbreak ®

A recent example of a passive automatically operated flip up barrier which requires no side walls has been developed and a patent was applied for (GB 1403974.7). This product, called Aquafragma, has the following characteristics:

1. The barrier turns to upright position automatically, requiring no power, no human intervention and no moving parts
2. The barrier is completely upright before flood water reaches the protected area, or liquid level exceeds the level of grade
3. The barrier is normally flat with grade, requiring, no threshold/ step or side walls
4. The construction of the barrier needs minimum excavation
5. For inland flood applications the barrier is returning automatically to flat position after the event
6. For wave overtopping coastal applications, where water level rises and drops the barrier is self locked in upright position
7. The barrier is robust both in normal position flat with grade and in operating condition upright position
8. The barrier is normally securely locked inside the housing and it is self unlocked before activation is required
9. The barrier top surface blends with the environment
10. The barrier issues warnings when rotation is imminent and when it is in operation

Conclusion

Flooding is a problem that is only getting worse. The recent floods directive brings into the institutional framework the concept of “living with the floods”. Flood resilience technology at property level provides a promising solution to this problem. Flood barriers are available in the market and new innovative products are entering the market. Climate change and the need to adapt to the future environmental conditions pose a challenge to engineers to develop solutions which are effective (minimising the flood risk) and efficient (minimising the cost).

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EN 752 Drain and Sewer systems outside buildings

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