# FLOODS

## The effects of floods on ports and their significance

Adequate protection against flooding is an elementary precaution for the functioning of a port. Flooding of a port directly disrupts its operations and can cause damage to goods, operational facilities and infrastructure. While damage to goods has primarily financial consequences, damage to facilities and infrastructure can affect the port's operations over a longer period of time and may impair its ability to function. Washouts and subsidence in quay walls, bridges, roads, and rails, as well as the destruction of switch drives, can severely affect traffic to and from the port over the longer term. Destruction of industrial facilities, for example at oil-processing plants, can bring their production to a standstill for months. In addition, the flooding of a port can damage its image.

**The monitoring**

For the effective dimensioning of protective measures, design principles are required. For this purpose, the relevant influencing parameters (water levels, water flow velocity, wind speed and direction, wave heights, rainfall, etc.) must be determined and, if possible, measured over the long term. By superimposing very unfavorable but at the same time conceivable boundary conditions, rated values with an accepted probability of occurrence are to be derived for the dimensioning of flood protection structures. Furthermore, climatic changes need to be estimated and included in the design.

**Steps to take to become resilient**

To make a port resilient to flooding, a combination of structural and organizational measures makes sense. Operational and governmental measures should complement each other.

Organizational measures include a disaster management organization with a central disaster management staff, regional disaster management staff and functional disaster management staff (police, fire department, specialized authorities, aid organizations), defense organizations to operate the flood protection facilities, crews to implement operational protection measures and well-defined communication channels to link up these actors. Reliable forecasts are also required so that the necessary defensive measures can be implemented in time. Suitable media, such as radio, automatic telephone announcements, Internet, SMS, apps, radio, television, must be used to disseminate warnings.

Structural flood protection measures include raised areas, dikes, flood protection walls and gates, pumping stations and mobile protection facilities.

When making decisions about long-term design of port areas, for example, new construction or restructuring, or construction of relevant and critical transportation infrastructure, flood protection requirements and future development of flood events should be considered. In new construction or restructuring of a port area, raising the entire area to a safe level of protection may be considered. In existing structures, however, area protection in confined areas should be provided by floodwalls or otherwise by dams.

Redundancies should be provided for movable equipment, such as gates and gate valves. In the case of gates, robust systems have proven their worth due to their high degree of fail-safety. Instead of equipping gates with complicated drive technology, it is useful to use industrial trucks that are available to close gates anyway.

It is also important to provide adequate protection for utilities and facilities (electricity, water, sewage, telecommunications, gas).

From an operational point of view, it is particularly important to protect the relevant processes and facilities. Often, individual particularly sensitive objects, e.g., power distribution boxes, fiber optic junction boxes, crane and switch drives, and ventilation systems can be elevated or encapsulated with relatively little effort so that they are not damaged by flooding.

## Case study - Sea Level Rise Port of Los Angeles

The Port of Los Angeles continues to develop and adapt capital improvement projects to remain resilient to Sea Level Rise. As global sea levels continue to rise, shoreline assets become more vulnerable to increase in the frequency and magnitude of coastal flood events. Sea level rise is a significant risk that can have a long-term impact on business operations as well as international cargo.

Therefore, the Port is taking a proactive approach to address the risk when investing in new infrastructure to avoid costly future improvements. The basis for the resiliency implementation is The Port of Los Angeles Sea Level Rise Adaptation Study, which evaluated Port assets including Cargo wharves and miscellaneous operations, critical facilities, transportation (rail/roads), community assets, and natural habitats. The Port of Los Angeles study included the development of sea level rise maps showing exposure for years 2030, 2050, and 2100, a vulnerability assessment, and development of adaptation strategies.

In the study, maps show permanent inundation based on state guidance levels occurring during normal, daily tide cycles. Flooding refers to temporary flooding that occurs with storm tides during the 100-year Stillwater elevation (SWEL) which is the summation of astronomical tides and storm surge (without wave effects). Flooding is temporary, less frequent, and less vulnerable than areas that are permanently inundated.

In addition, an overtopping analysis was performed to identify the most vulnerable areas and create targeted adaptation strategies. The overtopping analysis identified locations along the shoreline at lower elevations than future conditions' water level, therefore pinpointing the vulnerable area critical flood pathways.

The assets identified in the inventory were reviewed for exposure, sensitivity, and adaptive capacity. Assets that were found to be exposed to SLR were moved on to the sensitivity assessment. Similarly, assets found to be exposed and sensitive were evaluated for adaptive capacity. Assets are considered most vulnerable if they are exposed to flooding, have high sensitivity, and low adaptive capacity.

Resiliency strategies were developed for port assets that were determined as vulnerable based on the analysis. Resiliency strategies include updating governmental policies, implementing initiatives including regional and global collaboration, monitoring, and infrastructure development.