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in vocational education and training  
Project N°: 2022-1-SK01-KA220-VET-000086741



# PROFF

Protection against flash floods

## Climate change and protection from natural disasters

The project to help combat climate change

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# Workshop 5

## Coastal flooding and coastal erosion



# Introduction

- Coastal geomorphology is the study of the physical features and processes that shape the coast.
- It involves the examination of the landforms, sediments, and other features of the coastal zone, as well as the forces that shape them.
- Coastal geomorphology is a multidisciplinary field that draws on knowledge from geology, oceanography, ecology, and other sciences to understand the complex processes that occur along the coast.
- Understanding coastal geomorphology is important for managing coastal resources and mitigating the impacts of natural hazards such as storms, floods, and erosion.
- Coastal geomorphology is also important for understanding the impacts of human activities on the coast, such as coastal development and climate change.



# Coastal system

- Includes all of the processes, features, and interactions that occur between the land, ocean, and atmosphere at the coast.
- Is dynamic and constantly changing in response to natural and human-induced factors.
- The main components of the coastal system are the offshore zone, nearshore zone, beach, dunes, and coastal cliffs.
- The offshore zone is the area beyond the breaking waves and includes the continental shelf and deep ocean.
- The nearshore zone is the area between the shoreline and the offshore zone and includes the surf zone, swash zone, and beach face.
- The beach is the area between the shoreline and the dunes, and is typically composed of sand or gravel.
- The dunes are sand ridges that form behind the beach and help to protect the inland areas from storm surges and flooding.
- Coastal cliffs are steep rock formations that are found along some coastlines and are often eroded by waves and storms.

Naxos Island, Greece



# Coastal processes

- The coastal zone is constantly shaped by a variety of natural processes, including waves, longshore currents, surge/storm waves, and tides.
- Waves are generated by wind and ocean currents, and their characteristics (such as frequency, height, and direction) affect the coastal zone in different ways.
- Longshore currents run parallel to the shore and are generated by the oblique angle at which waves approach the coast.
- Surge/storm waves are caused by low pressure systems and can be particularly damaging to coastal areas during extreme weather events.
- Tides are the periodic rise and fall of sea levels, influenced by the gravitational pull of the moon and sun, and can affect sediment movement and erosion patterns.
- Other processes that affect the coastal zone include sea level rise, subsidence, and sediment supply.



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# What are floods?

- A flood is an overflow of water onto land that is normally dry.
- Floods can be caused by a variety of factors, including heavy rainfall, rapid snowmelt, dam failures, and coastal storms.
- Flooding can occur in both urban and rural areas, and can have devastating consequences for communities, including loss of life, damage to infrastructure, and economic disruption.
- Understanding the causes of floods is crucial for developing effective flood management strategies.
- In order to reduce the risk of floods, it is important to identify areas that are prone to flooding and implement measures to mitigate their effects.

Psachna, Euboea, Greece

Photograph: M. Tzouxanioti, 2020



# What are floods?

- **Flash floods:** caused by intense rainfall over a short period of time, resulting in rapid runoff and flooding of low-lying areas
- **River floods:** caused by prolonged rainfall or snowmelt, resulting in the overflow of rivers and their banks
- **Coastal floods:** caused by storm surges or tsunamis, resulting in the inundation of low-lying coastal areas
- **Urban floods:** caused by the inability of urban drainage systems to handle intense rainfall, resulting in flooding of streets and buildings
- **Agricultural floods:** caused by heavy rainfall or river overflows, resulting in inundation of farmland and damage to crops and livestock



# Coastal flooding

- Coastal flooding refers to the flooding of land along the coastline due to a variety of factors.
- Coastal flooding can be caused by storms, high tides, and storm surges.
- Storm surges occur when strong winds push water towards the coast, creating a higher water level.
- The effects of climate change, including rising sea levels and more frequent and severe storms, can increase the risk of coastal flooding.
- Coastal flooding can have serious impacts on coastal communities, including damage to homes and infrastructure, loss of life, and economic impacts.





# What is coastal erosion?

- Coastal erosion is the process by which the land is eroded, or worn away, by the action of water, wind, and ice along the coast.
- It is a natural process that has been occurring for thousands of years, but it has been accelerated by human activities such as coastal development, sand mining, and climate change.
- The primary causes of coastal erosion are waves, longshore currents, storm surges, and sea level rise.
- Coastal erosion can have negative impacts on the environment, such as loss of habitats for marine life, as well as on human settlements and infrastructure, such as coastal towns and roads.
- There are several measures to mitigate the impacts of coastal erosion, including hard engineering methods such as sea walls and breakwaters, and nature-based solutions such as beach nourishment and dune restoration.



# Morphological Features of the Coastal Zone

- Morphological features of the coastal zone refer to the physical characteristics of the coastline that are shaped by natural processes.
- Beaches are the most common feature of the coastal zone and are formed by the deposition of sediment by waves and currents.
- Rocky coasts are characterized by rocky cliffs and shorelines that are eroded by waves and weathering.
- Rocky cliffs are high and steep slopes made of hard rock that are formed through erosion and weathering.
- Estuaries are coastal features formed by the mixing of freshwater and saltwater, creating a unique ecosystem.
- Salt marshes are low-lying areas of wetland vegetation that are inundated by tidal waters.
- Dunes are hills of sand that are formed by wind and are stabilized by vegetation.
- Barrier islands are long, narrow strips of land that are parallel to the coast and are formed by sediment deposited by waves and currents.



# Natural Factors

- Coastal erosion and flooding are natural processes that occur due to a combination of natural factors.
- Climate change is one of the major natural factors that cause and affect coastal erosion and flooding, leading to sea level rise, changing storm patterns, and ocean acidification.
- Sea level rise, which is caused by the melting of ice sheets and glaciers, causes shorelines to retreat and increases the risk of flooding.
- Changing storm patterns, which can be caused by climate change, can result in more frequent and intense storms that cause erosion and flooding.
- Other natural factors that contribute to coastal erosion and flooding include waves, tides, currents, and sediment supply, all of which can be influenced by factors such as storms and sea level changes.



# Human Interventions

- Coastal development and urbanization
- Coastal armoring (sea walls, breakwaters, jetties)
- Dredging and beach nourishment
- Deforestation and land use change in watersheds
- Climate change mitigation and adaptation strategies
- Sustainability and ecosystem-based approaches to coastal management



# Mitigation Measures

## Hard Engineering Methods

- Sea walls
- Groynes
- Breakwaters
- Gabions
- Revetments

## Nature-based Solutions

- Beach nourishment
- Dune restoration
- Wetland restoration
- Salt marsh creation
- Reef restoration

## Integrated approaches

- Managed realignment
- Hybrid approaches
- Soft engineering methods
- Risk-based approaches

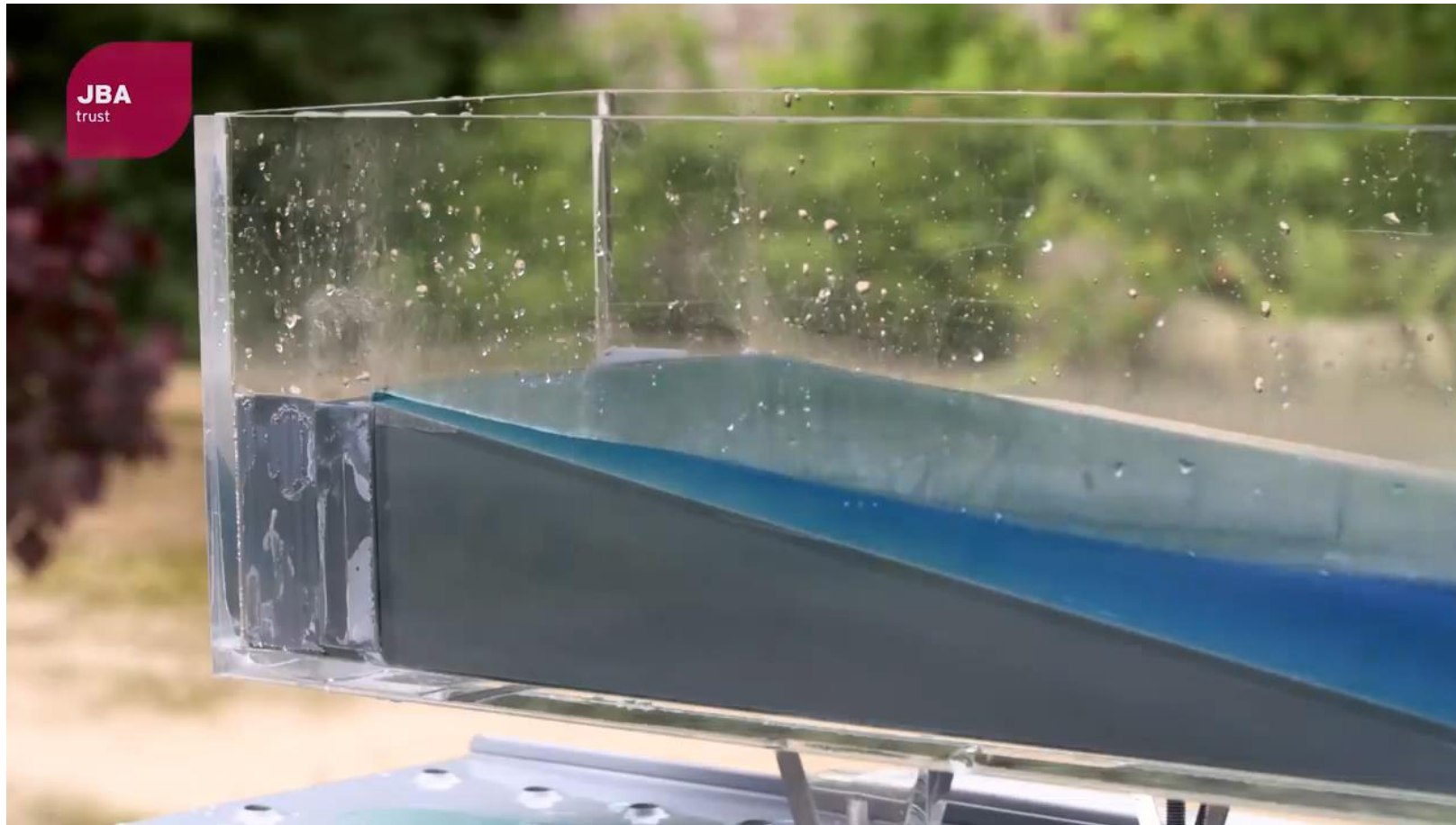


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# Wave Tank Simulations





# Protective Measures

- Protective measures are methods used to prevent or reduce coastal erosion and flooding.
- Some examples of protective measures include breakwaters, sea walls, jetties, beach nourishment, and mangrove restoration.
- Breakwaters are offshore structures that reduce wave energy and provide a calm area behind them, but can also trap sediment and cause erosion elsewhere.
- Sea walls are vertical structures built along the coast to block waves and protect the land behind them, but can cause reflection of waves and increased erosion at their base.
- Jetties are structures built perpendicular to the coast to maintain navigation channels, but can disrupt longshore drift and cause erosion on one side of the jetty.
- Beach nourishment involves adding sand to eroded beaches, but can be expensive and requires regular maintenance.



# Conclusions

- Coastal erosion and flooding are natural processes that are affected by both natural and human factors.
- The coastal system is complex and includes a variety of processes and features.
- Wave tank simulations are a useful tool for understanding the effects of coastal erosion and flooding.
- There are various protective measures available, including hard engineering methods and nature-based solutions.
- It is crucial to consider the advantages and disadvantages of different protective measures when choosing the best option for a particular location.
- The impact of climate change and sea level rise on coastal erosion and flooding is a growing concern.
- Further exploration of the topic can include investigating alternative nature-based solutions and assessing the social and economic impacts of protective measures.





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**Thank you for your attention**



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