

Potential implications of climate change for inland and maritime navigation and for seaports

This paper was prepared and endorsed in June 2009 by members of the European WFD Navigation Task Group<sup>1</sup> as an input to the WFD Common Implementation Strategy drafting group preparing the Guidance document No. 24 River Basin Management in a Changing Climate<sup>2</sup>.

1. Potential **implications of climate change** for inland navigation, sea ports and maritime navigation

<b>Climate change characteristic</b>	<b>Potential implications for inland navigation</b>	<b>Climate change characteristic</b>	<b>Potential implications for seaports and maritime navigation</b>
Increased (eg. winter) precipitation	Increased frequency of: Strong Stream or out-of-channel events; reduced freeboard; reduced operating headroom or clearance all with potential to interrupt navigation. Increased risk to structural integrity of navigation/logistics assets and infrastructure (eg. due to seepage, overtopping or erosion); reduced capacity (sluices, culverts, etc.)	Sea level rise	Reduced capacity of infrastructure. Increased risk of overtopping or flooding; operational issues (eg. vessel relative to quay); bridge clearance; increased risk of pollution/ emissions in flooded areas. Changes in salinity and extent of brackish zone potentially affecting port infrastructure.
Reduced (eg. summer) precipitation	Increased frequency of low flow events and hence carrying capacity; increased risk of groundings*; increased frequency of water resource shortages; risk to integrity of certain navigation assets and infrastructure	Increased storminess; wave heights; storm surges; tidal prism. Increased precipitation	Coastal erosion; flooding. Disruption, damage to port infrastructure, increased downtime (vessels at berth; port; supporting transport infrastructure). Increased risk of accidents. Increased run-off with consequences for sedimentation.
Increased air temperature	Drying out of banks (increased potential for fissuring, settlement, erosion, undercutting); changes in characteristic vegetation types	Increased water temperature	Survivability of non-indigenous species, implications of/for ballast water management; port industry discharges
Increased air/water temperature	Increased growth of bankside and aquatic vegetation; increased risk of algal blooms (associated health risks; loss of amenity value for recreational users)	Increased air temperature	Heatwaves causing disruption or damage (eg. to terrestrial transport infrastructure)
Consequences of above for sediment regime	Potential changes in erosion and deposition; sediment accumulation; changes in concentrations of contaminants	Consequences of above for sediment regime	Changes in suspended sediment level; erosion; deposition/accumulation; changes in concentrations of contaminants

\* particularly on rivers without River Information Systems and on recreational water bodies

<sup>1</sup> The WFD Navigation Task Group is a 'thematic cluster' of European navigation-related organisations which provides the navigation sector's contribution to the WFD Common Implementation Strategy (CIS). The Task Group comprises the following professional bodies, trade associations and other stakeholders concerned with ports, commercial and leisure navigation and dredging: Central Dredging Association; European Barge Union; European Boating Association; European Boating Industry; European Community Shipowners' Associations; European Dredging Association; European Federation of Inland Ports; European Sea Ports Organisation; ICOMIA; PIANC; and Inland Navigation Europe. Central Commission for Navigation on the Rhine, the Danube Commission and the International Sava River Basin Commission are also invited to attend our meetings as observers.

<sup>2</sup> It was then slightly modified to clarify the consequences for the sediment regime following the ClimWatAdapt workshop in October 2010.

2. Potential **climate change adaptation** measures (suitability typically dependent on both climate change scenario and site specific characteristics)

<b>Inland navigation consequence</b>	<b>Potential adaptation measures</b> (some may already be in place)	<b>Maritime navigation consequence</b>	<b>Potential adaptation measures</b> (some may already be in place)
Safety issues of increased frequency of Strong Stream conditions, low flow events, etc.	Long term data collation and management. Ensuring effective communication of warnings to users*; awareness raising; behavioural change where necessary. Provision of additional temporary moorings; safe havens, etc. Vessel design options (where practicable)	Infrastructure capacity, vulnerability	Assess risks; survey assets; collate data; create long term database to inform decision making.
Implications of more frequent extreme conditions for integrity of physical infrastructure	Adaptive management: modify survey frequency, flexibility in maintenance operations and management regimes; 'climate-proof' ongoing operations and new development projects	Infrastructure capacity, vulnerability	Reduce exposure; increase freeboard; raise protecting structures (flood defences, breakwaters); protect infrastructure or assets against wave or wind energy, erosion, extreme heat
Water flow, quantity implications of reduced seasonal precipitation	Integrated, multi-disciplinary water storage, supply and use assessment and implementation; (additional) water conservation measures in waterway operation and maintenance (eg. locks, sluices)	Flood risk	Modify or raise assets or infrastructure; build up intertidal areas; beach nourishment; respond to coastal squeeze; install drainage systems; retrofit SUDS
Changes in erosion, siltation	Reduce sediment run-off; soft engineering bank protection. Reduce vessel-induced waves/currents (eg. practicability of speed limits, modifications to vessel design)	Changes in sedimentation	Increased dredging requirements; modify dredging methods or disposal options
Sediment accumulation	Increased dredging requirements	Risk of incidents or accidents	Contingency planning; effective communication of warnings.
Increased plant growth; change in species types	Increased frequency of cutting, clearance activities; role of vegetation in structural integrity; alien species management	Establishment or migration of alien species	Modify or improve ballast water management or anti-fouling systems
Increased recreational demand	Multi-functional infrastructure planning and management combining water use functions; 'climate-proof' new developments.	Opportunities for renewable energy supply or generation	Shore-side electricity from renewable source; wind, wave or tidal power
Opportunities for renewable energy generation	Wind turbines; heating and cooling systems; hydropower; lock power		

\* on rivers without River Information Systems and on recreational water bodies