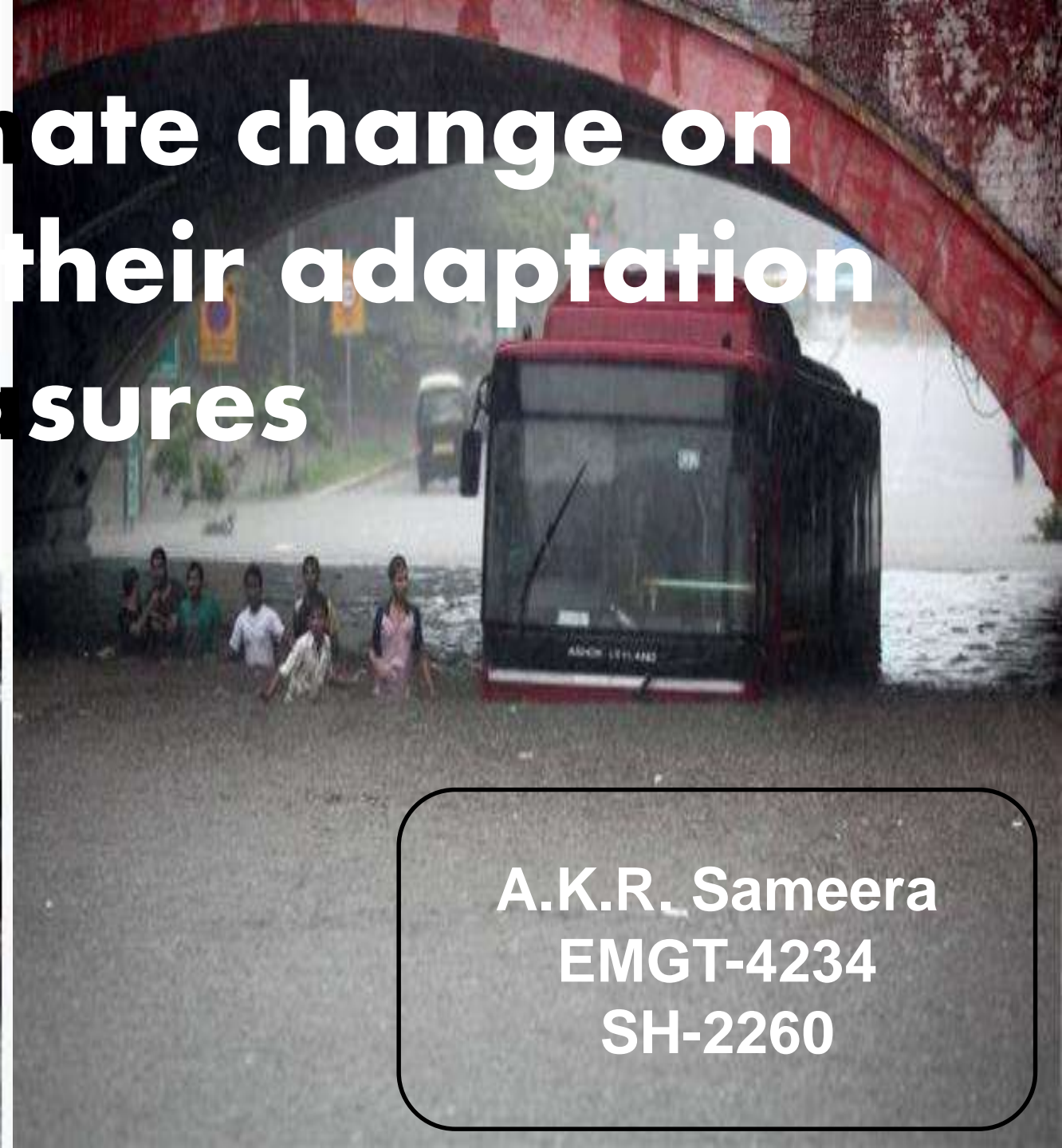


Effects of climate change on transport and their adaptation measures



A.K.R. Sameera
EMGT-4234
SH-2260

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Introduction

- Climate change is considered one of the most important environmental issues of our time. At present climate change affect to the world in many of the sectors.
 - i. Agriculture
 - ii. Human health
 - iii. Eco systems
 - iv. Water resources
 - v. Infrastructure
 - vi. Settlement
 - vii. Tourism
 - viii. **Transport**

What is Transportation?

- The process by which passengers or goods are moved or delivered from one place to another.
- Transportation Systems Identify the Four basic types
 - A. Land
 - B. Air
 - C. Water
 - D. Space

Climate change & transportation

- Nowhere will the impacts of climate change be greater and the need for adaptive responses more apparent than in the built transportation, especially the vast network of highways, railroads, transit systems, airlines, sea routes and so on.
- Based on the climate-science literature, one can conclude that in the next 50 to 100 years five specific impacts of global warming will have potentially serious implications for the built transportation system: sea level rise (virtually certain, > 99 percent probability); heat waves (very likely, > 90 percent); rising Arctic temperatures (virtually certain, > 99 percent); changes in precipitation patterns(very likely, > 90 percent); and increasingly intense, strong hurricanes(likely, > 66 percent) (IPCC, 2007; NRC, 2008)

Why we should focus climate change adaptation to transportation

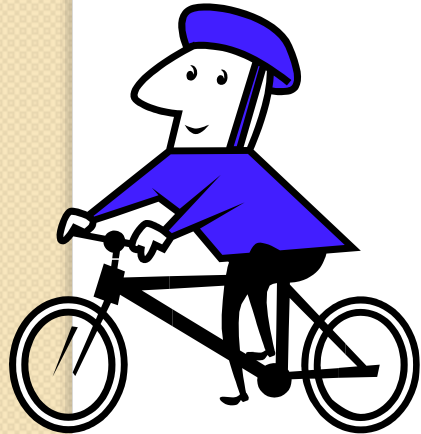
- Some obvious impacts to the transportation systems are traffic disruption due flooding and heavy snow and rains, difficult driving conditions, increase in maintenance requirement to the pavement due to high temperature and more frequent icing-thawing phenomenon, overflow of side drains and cross drainage works, submerged bridges due to floods induced by intense precipitation, inundation of coastal roads due to sea level rise , and road blocks due to landslides.

Continued...

- What are the most vulnerable transport infrastructure components to the climate change and what are the impacts? How the climate change will affect current practice of design, construction and operation of transport infrastructure? How can we develop more resilient transport infrastructure through adaptation?

Climate change effect on Road infrastructure and adaptation

- Systems that move goods and people from one place to another on earth.

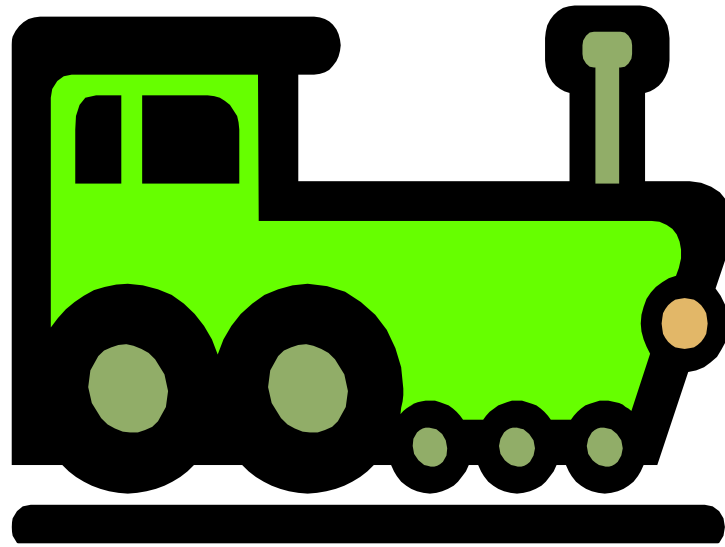


Relevant climate impacts	Impact on road infrastructure	Possible adaptation measures
Increased temperature and more heat waves	<ul style="list-style-type: none"> • Deformations of roads, slowing down or disrupting transport ,melting of asphalt/dark surfaces • Increased asphalt rutting due to material constraints under severe exposure to heat • Thermal expansion on bridge expansion joints and proved surfaces • Bridge structural material degradation 	<ul style="list-style-type: none"> • Planting roadside vegetation • Reduce overall exposure and provide cooling through green and blue infrastructure • Proper design/construction ,overlay with more rut –resistant asphalt or more use of concrete • New design standards may be needed to withstand higher temperatures • Increased maintenance
more frequent droughts (and less soil moisture)	<ul style="list-style-type: none"> • dry soil in combination with more intense rains will lead to more landslide and subsidence • Road foundation deration due to increased variation in wet /dry spells and a decrease in available moisture • Dust and from several d sand on roadways can be a safety hazard from several perspective including reduced friction in braking, as well as less sighting of roadway makings. 	<ul style="list-style-type: none"> • assess the likeliness of impacts on road infrastructure(risk mapping) • Avoid new developments in high –risk areas • Monitoring of soil condition of existing roads • Increased cleaning and maintenance of roadways.
sea level rise and costal erosion	<ul style="list-style-type: none"> • risk of inundation of road infrastructure and flooding of underground tunnels in coastal cities • Degradation of the roadway surface and base layers from salt from salt penetration 	<ul style="list-style-type: none"> • create vulnerability maps to identify areas most at risk • Strict developments in high-risk areas ,e.g. along the shoreline: zoning • Intergrade transport planning with costal zone management • Improved drainage ,pumping of underpasses and elevating roads

Relevant climate impacts	Impact on road infrastructure	Possible adaptation measures
More extreme rainfall events and flooding	<ul style="list-style-type: none"> • Flooding of roadways and subterranean tunnels, especially where drainage is inadequate • Road damages and decrease of structural integrity due to erosion ,landslide and increasing soil moistures levels. 	<ul style="list-style-type: none"> • improve drainage infrastructure • Audit drains regularly • Enhanced pumping • Create flood map • Restrict developments in high-risk area • Improve flood pain management • Early warning systems and evacuation planning
More intensive and frequent storms	<ul style="list-style-type: none"> • Damage to infrastructure fabric ,bridges ,flyovers ,stress lighting ,signs and service station • Risk of inundation by the sea during high winds ,especially in combination with high tides sea level rise. 	<ul style="list-style-type: none"> • assesse if currently used design standards can withstands more frequent and intense stomps • Adapt design standards

Climate change effect on Rail Road and adaptation

- Transportation system made up of metal rails which is designed to allow trains to maneuver on the tracks from one location to the next

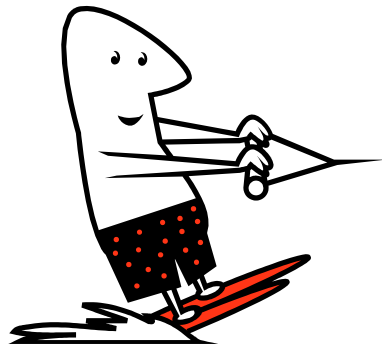


Relevant climate impacts	Impact on rail	Possible adaptation measures
Increased temperature and more heat waves	<ul style="list-style-type: none"> • bulking of rails and track movement because of thermal expansion leads to slowing down or disruption of transport • Increased temperatures in underground network 	<ul style="list-style-type: none"> • Adapted maintenance procedures • New design standards may be needed for rails to withstand higher temperatures • Improve systems to warn and update dispatch centres, crews, and stations. • Better cooling systems or air conditioning for underground networks • Hot weather contingency plans • Design standard for power supply.
more frequent droughts	<ul style="list-style-type: none"> • Dry soils in combination with more intense rains will lead to more landslides and subsidence 	<ul style="list-style-type: none"> • Assess the likeliness of impacts on the railway infrastructure • Monitoring high risk tracks regular maintain • Avoid new rail line in high risk area
Sea level rise and coastal erosion	<ul style="list-style-type: none"> • Risk of inundation of rail infrastructure and flooding of underground tunnels in coastal cities 	<ul style="list-style-type: none"> • Create vulnerability maps to identify areas most at risk • Restrict development in high risk areas • Integrated transport planning with coastal zone management • Enhance protective measures such as sea walls, protection of coastal wetlands, pumping of underground system

Relevant climate impacts	Impact on rail	Possible adaptation measures
<p>More extreme rainfall events and flooding</p>	<ul style="list-style-type: none"> • Flooding can affect all mode of transport. • Increases in flooding of rail lines and underground tunnels • Railbed damages and decrease structural integrity due to erosion, landslides and increasing soil moisture levels • Underground systems/tunnels may be flooded • Increased weathering of infrastructures 	<ul style="list-style-type: none"> • Improve or build drainage infrastructure • Audit drains regularly • Create flood maps • Make flood –risk assessments • Improve flood plain management • Passenger evacuation plans for underground systems • Enhanced Pumping • Use more durable material • Improved maintenance
<p>More intensive and frequent storms</p>	<ul style="list-style-type: none"> • Damage to station/Infrastructure • Risk of inundation by the sea during winds, especially in combination with high tides and sea level rise • Obstruction of roads or rails due to fallen trees 	<ul style="list-style-type: none"> • Assess if currently used design standards • Adapt design standards • Improve weather forecasting • Wind forces for open rail infrastructure • For overhead lines :Circuit breaker protection • Adapt design standard formation equipment • Emergency Planning

Climate change effect on Water ways and adaptation

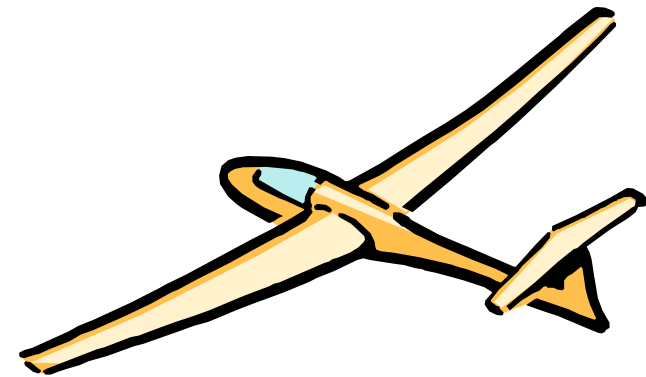
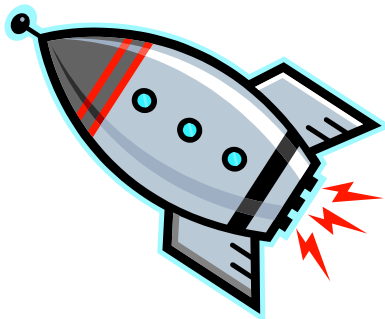
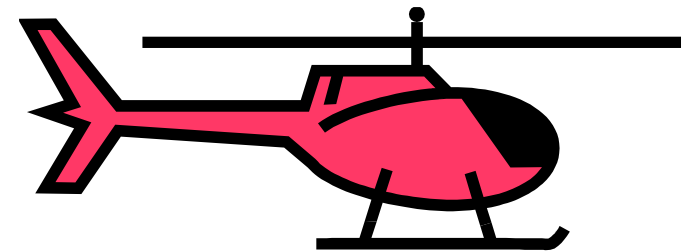
- The use of water to support the vessel in the transport of people or goods.



Relevant climate impacts	Impact on water ways	Possible adaptation measures
Increased temperature and more heat waves	<ul style="list-style-type: none"> Increased aquatic Vegetation growth could lead to clogging 	<ul style="list-style-type: none"> Intensify maintenance of relevant waterways
more frequent droughts	<ul style="list-style-type: none"> Decreased water availability in waterways could restrict their use and lead to more use of road networks 	<ul style="list-style-type: none"> Change s to navigation Assess the viability of flow augmentation
Sea level rise and coastal erosion	<ul style="list-style-type: none"> Port facilities and coastal waterways could become unusable 	<ul style="list-style-type: none"> Enhance flood defenses such as sea walls ,protection of coastal wetlands
More extreme rainfall events and flooding	<ul style="list-style-type: none"> Reduced clearance under waterway bridges Reduced navigability of rivers and channels 	<ul style="list-style-type: none"> Plan for the usage of alternative transport made Incorporate higher levels of flooding into future bridge design
More intensive and frequent storms	<ul style="list-style-type: none"> Storms damage on waterway Obstruction of rivers and channels due to floating debris 	<ul style="list-style-type: none"> Increase structural monitoring and main structural maintenance Contingency planning

Climate change effect on Air transport and adaptation

- The use of airplanes, helicopters, and dirigibles to lift passengers and/or cargo into the air in order to move from place to place.



Relevant climate impacts	Impact on Airport	Possible adaptation measures
Precipitation change	<ul style="list-style-type: none"> • disruption to operations e.g. airfield flooding, ground subsidence • reduction in airport throughput inadequate drainage system capacity • inundation of underground infrastructure (e.g. electrical) • inundation of ground transport access (passengers and staff) 	<ul style="list-style-type: none"> • Improve weather forecasting • assess the likeliness of impacts on ground transport (risk mapping)
Temperature change	<ul style="list-style-type: none"> • changes in aircraft performance • changes in noise impact due to changes in aircraft performance • heat damage to airport surface (runway, taxiway) • increased heating and cooling requirements 	<ul style="list-style-type: none"> • Assess the likeliness of impacts on the airport infrastructure • Monitoring high risk tracks regular maintain • Avoid new Air line in high risk area
Sea-level rise	<ul style="list-style-type: none"> • loss of airport capacity • impacts on en-route capacity due to lack of ground capacity • loss of airport infrastructure • loss of ground transport access 	<ul style="list-style-type: none"> • Enhance protective measures such as sea walls, protection of coastal wetlands, pumping of underground system • Managed retreat, possibly including abandoning of certain transport infrastructure in the mid to long term
Wind changes	<ul style="list-style-type: none"> • convective weather: disruption to operations • convective weather: route extensions • jet stream: potential increase in en-route turbulence • local wind patterns: potential disruption to operations and changes to distribution of • noise impact 	<ul style="list-style-type: none"> • Improve weather forecasting
Extreme events	<ul style="list-style-type: none"> • disruption to operations, route extensions • disruption to ground transport access • disruption to supply of utilities 	<ul style="list-style-type: none"> • Improve weather forecasting • assess the likeliness of impacts on ground transport (risk mapping)

Conclusion

- Climate change is considered one of the most important environmental issues of our time. At present climate change affect to the world in many of the sectors. Among sectors transport is the one of the important area.
- Nowhere will the impacts of climate change be greater and the need for adaptive responses more apparent than in the built transportation, especially the vast network of highways, railroads, transit systems, airlines, sea roots and so on.
- If there is effect on transport by climate change we can adapted those effect above I mentioned.

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Thank You

