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University of Strathclyde Glasgow

Integrated Wireless Sensing Technology for Surveillance & Monitoring of Bridge Scour

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Scour in the UK

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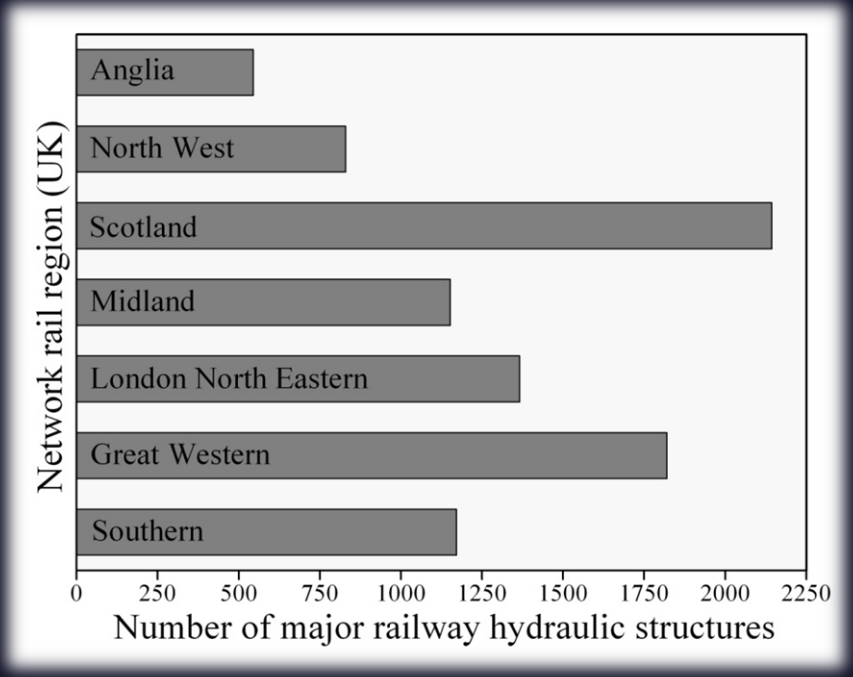
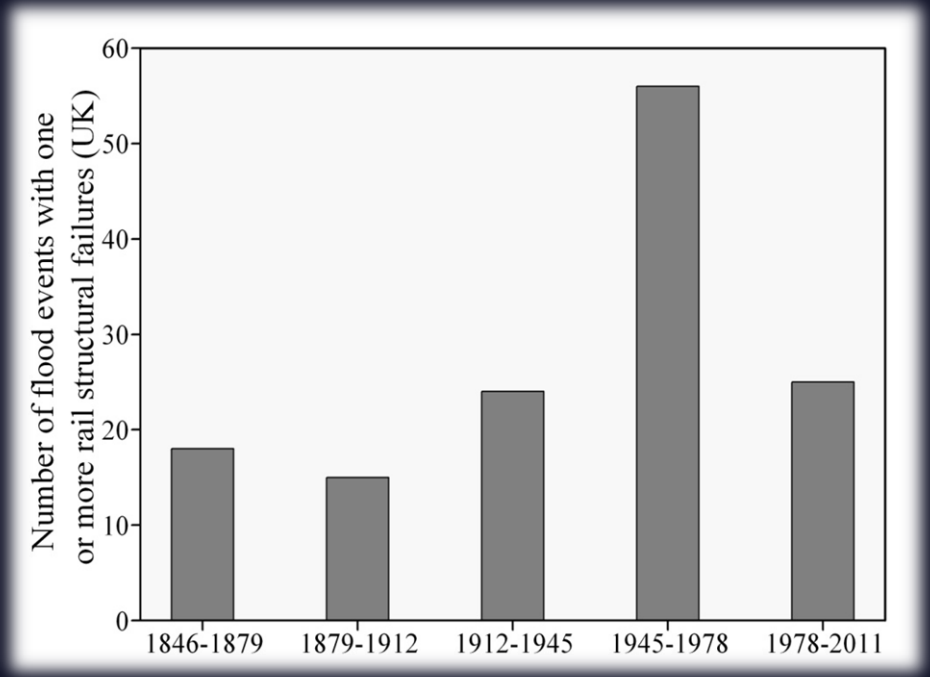
- Scour is identified as key risk to infrastructure arising from the long term gradual climate change *(Defra, 2012)*.
- 40% chance that at least one rail structure will fail each year due to a flood event *(JBA, 2004)*.





- Main cause of more than 130 railway bridge failures in the UK with an average cost of damage over £1 million/year *(RSSB, 2005)*.

Bridge Failures

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- Scour is inspected visually due to technical and cost issues.
- It can cause sudden loss to a structure without apparent signs of impending failure.

The collapsed Northside bridge in Workington (Cumbria, 2009) *(source: Byrne, 2009).*

The Malahide viaduct failure (Ireland, 2009) *(source: RAIU,2011)*.

Project Aim

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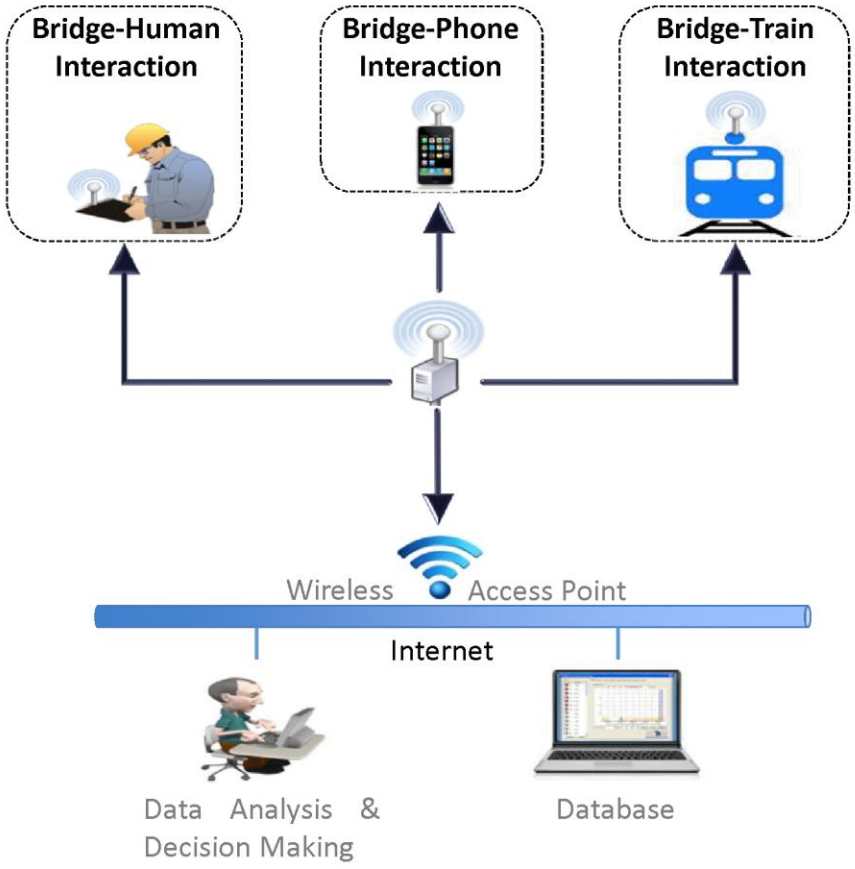
To develop a Scour Monitoring System in order to provide real-time safety surveillance.



Scour Detection Technique

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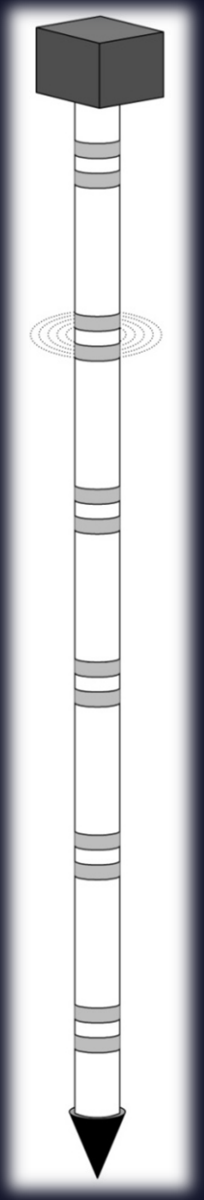
- The capacitive principle is used for the first time for scour/deposition monitoring.
- Scour probe is equipped with several capacitive sensors.
- Between the two rings a high frequency electromagnetic field is generated penetrating the soil outside the tube.
- The signal of the sensor is a function of the permittivity of the medium surrounding the shaft.



Scour Monitoring System

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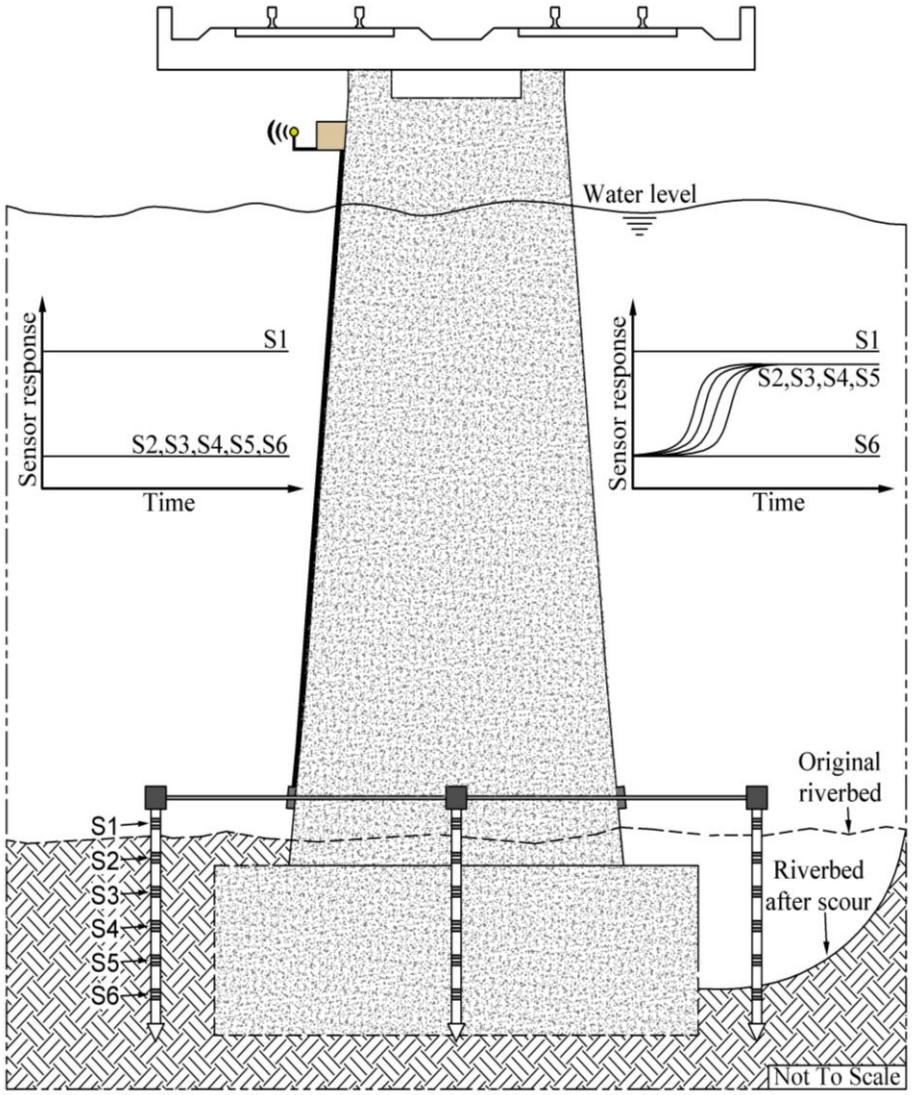

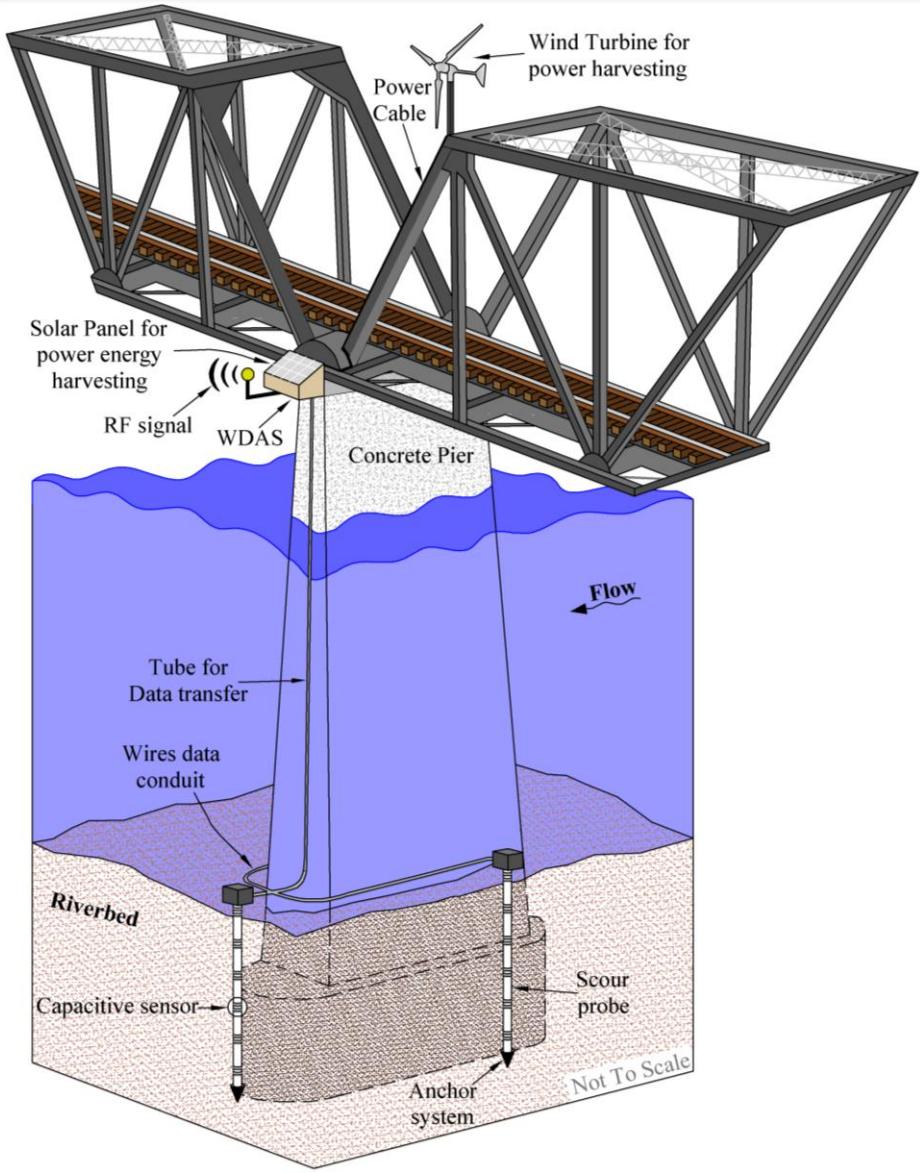

Experimental Testing

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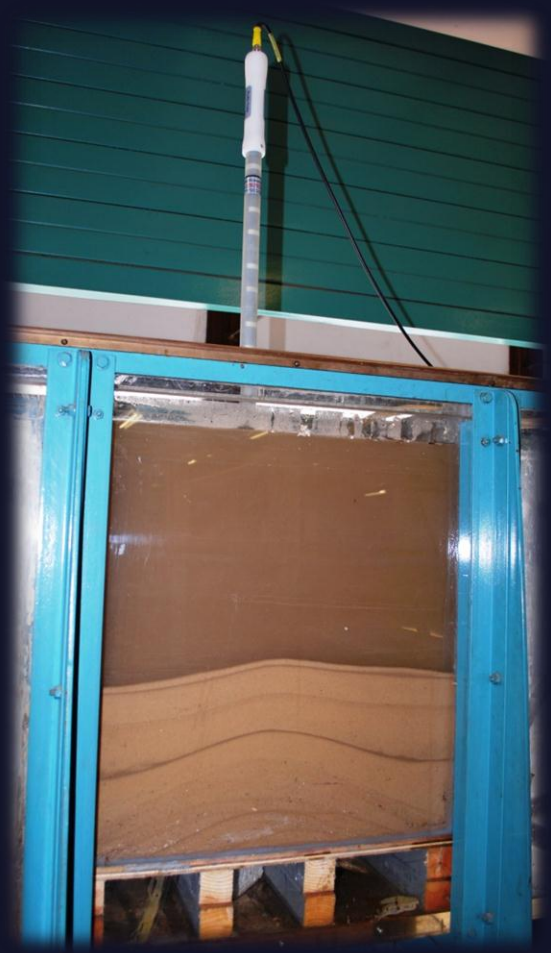
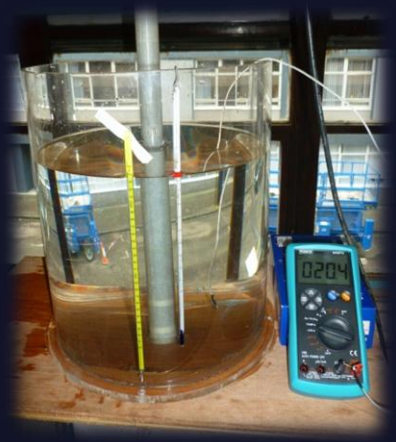
Sensor evaluation under different environmental conditions:





Sensor Evaluation

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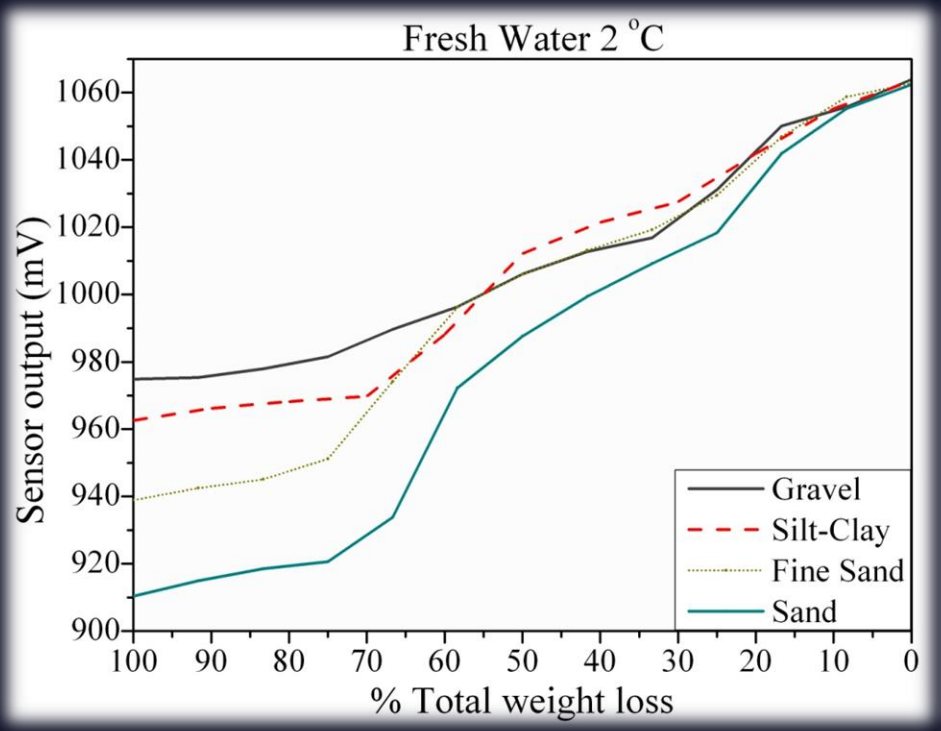
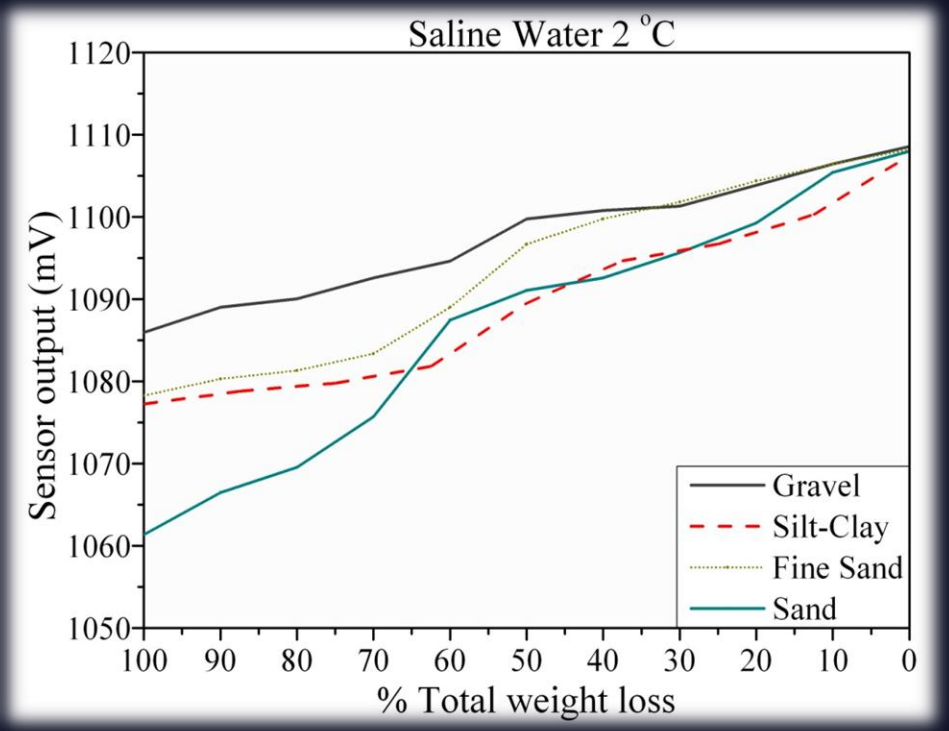
- *Long term degradation test:*





Sensor Evaluation

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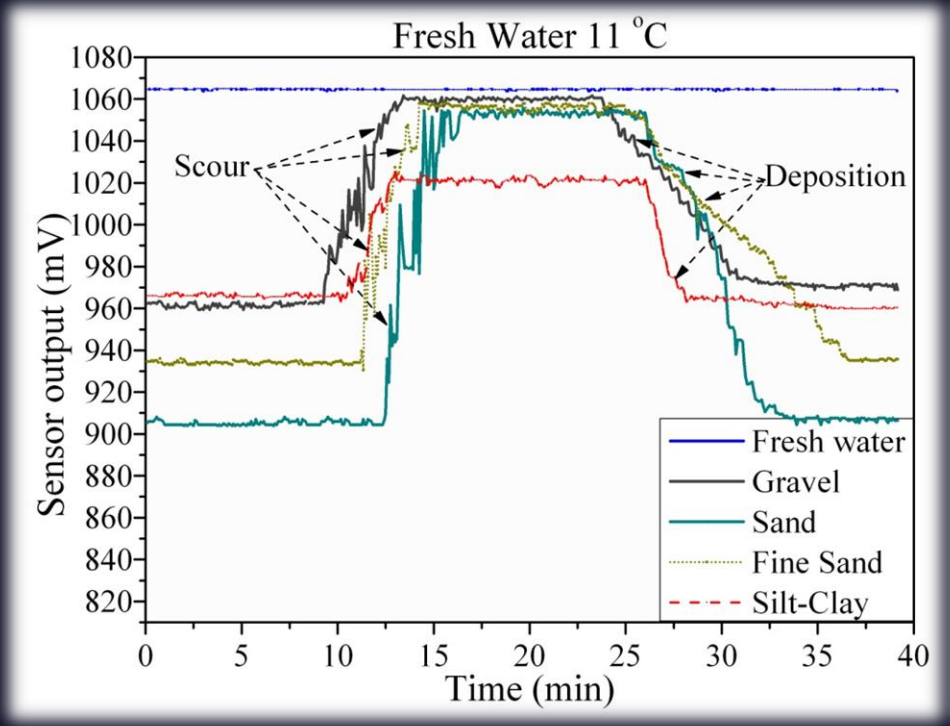
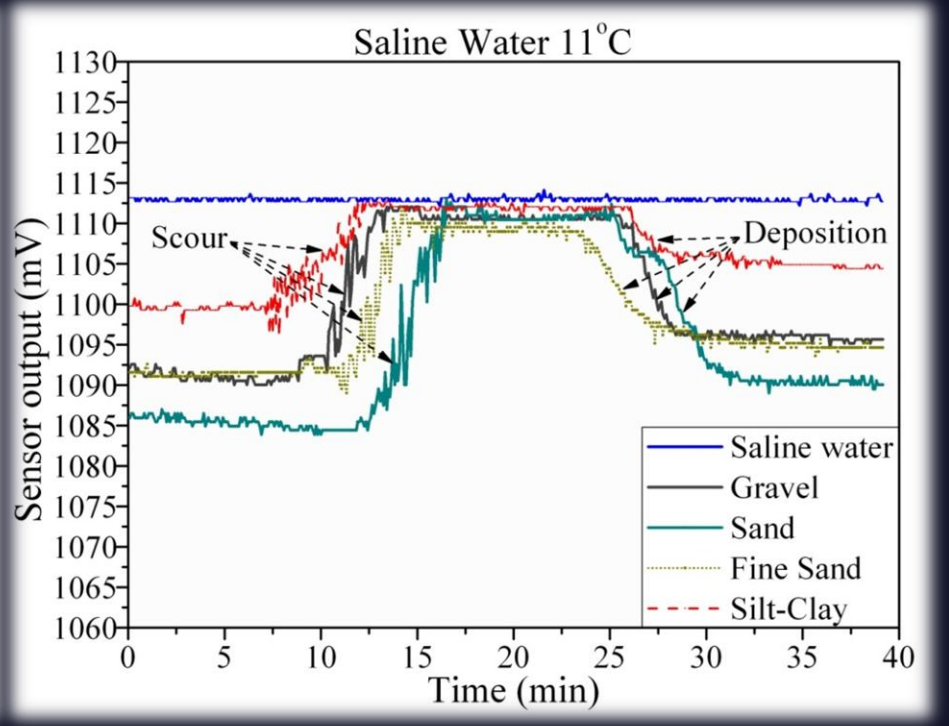
- *Scour/sediment deposition test:*





Sensor Evaluation

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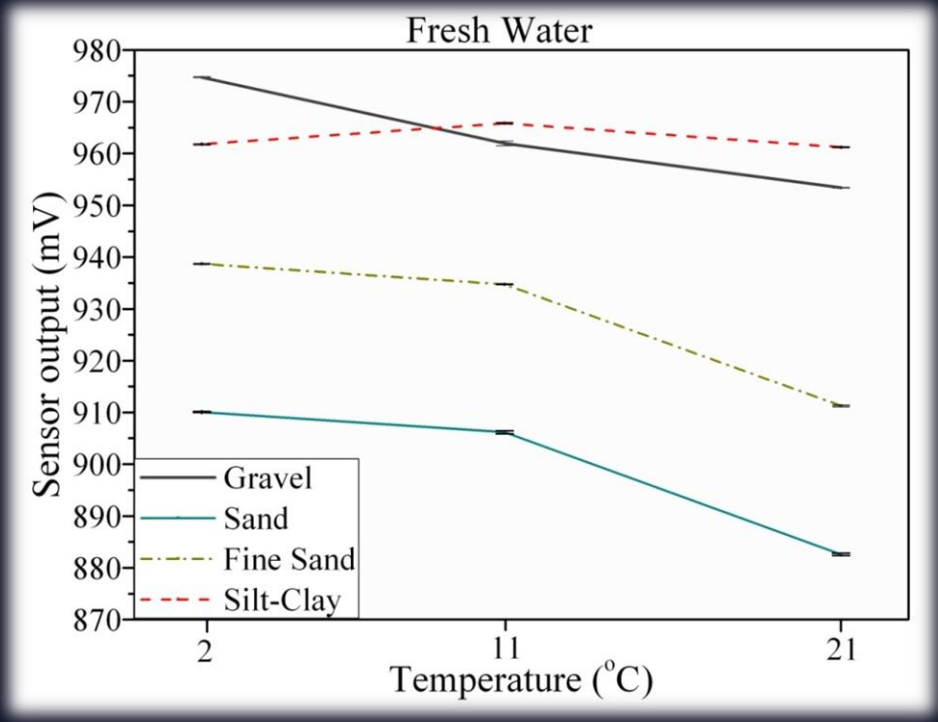
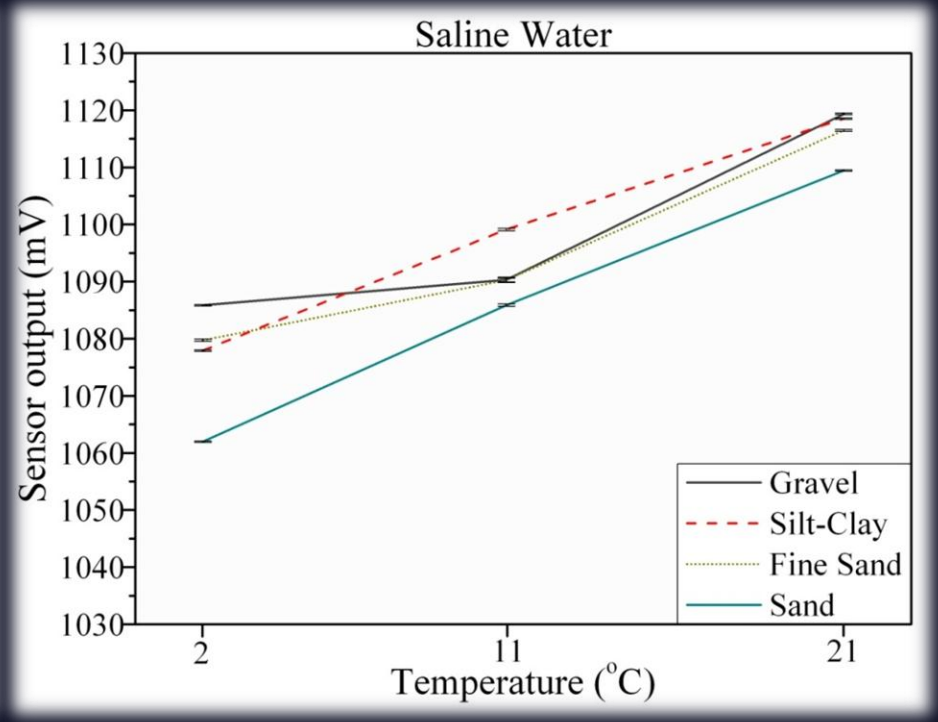
- *Temperature influence:*





Comparison

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Method	Scour/Deposition monitoring	Accuracy	Durability	Applicability	Cost ($)
Diving	X	Low	N/A	Low	1,000*
Sonar	✓	High	Medium	Medium	5,000-15,000**
Automatic Sliding Collar	X	Medium	High	Medium	10,000***
Ground Penetrating Radar	✓	High	Medium	N/A	3,000-10,000*
Global Positioning System	X	High	N/A	Low	5,000-20,000**
Float out devices	X	Medium	Low	Low	3,500***
Optical sensors	✓	High	Medium	N/A	5,000-10,000*
Time Domain Reflectometry	✓	High	Medium	Medium	15,000***
Tilt/Vibration Sensor devices	X	High	High	High	500***
Sounding Rods	X	Low	Medium	Low	7,500***

*Chen et al (2011) **Lagasse et al (2009) ***Lueker et al (2010)

Capacitance Scour Probes	✓	**High**	**Work in Progress**	**Work in Progress**	**300**

Conclusions & Next Steps

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- ✓ High conductivity due to increased temperature and salinity was found to have contrasting effects on the sensor output amplitudes.
- ✓ Technique is capable of monitoring scour and sediment deposition processes under different environmental conditions.
- ➢ A new capacitive sensor with an improved geometry is currently being trialled in the laboratory.
- ➢ Development of monitoring system and implementation to a scour-critical bridge is planned.
- ➢ Application of the monitoring technique to offshore wind turbine foundations is proposed.

Q & A

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