Institution: Plymouth University

Unit of Assessment: Earth Systems and Environmental Sciences B7

Title of case study: Coastal Video Research In Support of Coastal Zone Management

1. **Summary of the impact** (indicative maximum 100 words)

The Coastal Processes Research Group (**CPRG**) at Plymouth University has developed new methodologies, utilising video systems to efficiently monitor and manage the coastal environment. This research has impacted upon coastal managers, mariners, coastal communities, tourists and industries, for example, by reducing the risk of coastal flooding, drowning in rip currents and ships running aground. Algorithms, methodologies and systems developed by the CPRG, trigger appropriate and timely management intervention to protect coastal communities from flooding, instruct dredging operations and effectively manage recreational beach resources.

2. Underpinning research (indicative maximum 500 words)

The ability to monitor, understand and predict coastal change is becoming increasingly important given global climatic change, sea level rise and increased storminess. Our coastal environments are a valuable resource for industry and recreation with over 50% of the European population living within the coastal zone. Motivated by scientific endeavour to monitor and understand the changing shape of our coastline, Davidson (Associate Professor at PU 1992 to present) initiated coastal video research in the UK with the installation of the first system in 1996 at Perranporth.

The scientific success of this work is evidenced by Davidson's inclusion as named investigator on 10 peer reviewed video-related research projects with a value exceeding £5M of over the past 15 years. This research highlighted the potential of video technology for practical coastal zone management, leading to Davidson's co-ordination of the EU CoastView project. CoastView [2001-4] investigated the role of coastal video systems for monitoring and managing coastal environments. This ambitious £1.3M project engaged 14 partners from 7 countries and involved four national scale coastal managers from the UK, Spain, Netherlands and Italy. The project developed a set of video-derived coastal state indicators (e.g. parameters quantifying beach width/volume, the location of dynamic navigation channels and the spatial density distribution of beach users) that informed the coastal management process in the areas of coastal protection, navigation and recreation.

CoastView demonstrated that coastal state indicators (CSIs) in isolation did not ensure effective coastal management and required implementation within a carefully designed 'Frame of Reference' (FoR) system [R3-4]. The CoastView project extended and demonstrated the utility of the FoR system in all areas of coastal management, setting a precedent that has been followed by numerous applied research projects (e.g., MICOR, Ecoshape and CONSCIENCE).

CoastView also investigated the dual advantages that could be gained from combining numerical models with video data. Firstly, it was demonstrated that video-derived parameters (e.g., bathymetry and wave parameters) could be used to provide up-to-date boundary conditions for numerical models, improving the accuracy of forecasted sediment erosion and accretion. Secondly, these inexpensive, robust systems provide a unique opportunity to acquire long-term (decadal) datasets, facilitating the development, calibration and validation of data-driven models for coastal change.

CoastView's success led to a succession of research projects focusing on the modelling and prediction. In 2009 Davidson developed a new model [R1&2] that skilfully hindcasts the temporal evolution of the shoreline, a prime concern for coastal managers. More impressively, this new model significantly outperforms existing models for forecasting shoreline change with a prediction horizon of approximately a decade.

On-going research projects involves a close collaboration with the University of New South Wales and is extending the present model to forecast shoreline change in a changing climate. Other current projects involving coastal video systems aim to: better understand the dynamics of rip currents, motivated by beach safety (and working with the RNLI); improve our understanding of gravel beach dynamics and examine the resilience to flooding of coastlines fronting the UK's nuclear power stations.

3. References to the research (indicative maximum of six references)

Six selected international, peer-reviewed, academic journal articles: Plymouth University Staff are highlighted in bold and were major contributors to all the listed publications.

R1. **Davidson MA**, Lewis RP, Turner IL., 2010. Forecasting seasonal to multi-year shoreline change. COASTAL ENGINEERING 57(6): 620-629 Impact factor 2.553, peer reviewed.

R2. **Davidson MA**, Turner IL., 2009. A behavioural template beach profile model for predicting seasonal to interannual shoreline evolution. JOURNAL GEOPHYSICAL RESEARCH 114: Article number F01020 Impact factor 3.174, peer reviewed

R3. **Davidson M**, Van Koningsveld M, de Kruif A, Rawson J, Holman R, Lamberti A, Medina R, Kroon A, Aarninkhof S., 2007. The CoastView project: developing video-derived coastal state indicators in support of coastal zone management. COASTAL ENGINEERING 54(6-7): 463-475. Impact factor 2.553, peer reviewed.

R4. Kroon A, **Davidson MA**, Aarninkhof SGJ, Archetti R, Armaroli C, Gonzalez M, Medri S, Osorio A, Aagaard T, Holman RA, et al., 2007. Application of remote sensing video systems to coastline management problems. COASTAL ENGINEERING 54(6-7): 493-505. Impact factor 2.553, peer reviewed.

R5. **Morris BD, Davidson MA, Huntley DA,** 2001. Measurements of the response of a coastal inlet using video monitoring techniques. MARINE GEOLOGY 175(1-4): 251-272. Impact factor 2.955, peer reviewed

R6. **Kingston KS**, Ruessink BG, van Enckevort IMJ, **Davidson MA,** 2000. Artificial neural network correction of remotely sensed sandbar location. MARINE GEOLOGY 169(1-2): 137-160. Impact factor 2.955, peer reviewed

4. Details of the impact (indicative maximum 750 words)

The CPRG has developed **techniques** and software for the extraction of key parameters from coastal video images that are designed to help effective monitoring, management and protection of the coastal **environment**. These video-derived parameters are given the generic term Coastal State Indicators or CSIs. CSIs are designed to facilitate effective, efficient and timely intervention in a diverse range of management areas including, coastal protection, navigation and recreation. As well as increasing management efficiency and saving time and money, CSIs also ameliorate **risks**. Examples include prevention of coastal erosion and flooding, warning systems for the incidence and location of rip currents and avoiding the grounding of ships on sandbanks. Beneficiaries of this work include coastal communities, businesses, managers, mariners and recreational users.

Examples of the impact and beneficiaries include the national coastal managers for the Netherlands, *Rijkswaterstaat,* who benefited through the development of new methodologies for monitoring and managing coastal erosion. The Intertidal Momentary CoastLine (IMCL) is a CSI that measures the shoreline position (R4). Developed jointly between the CPRG, *WL Delft Hydraulics* and the *Rijkswaterstaat*, the IMCL can be used to assess shoreline erosion and accretion, and trigger beach replenishment, protecting coastal communities from flooding. The unique advantage of this methodology is that a daily measurement of the shoreline can be obtained using the video systems compared to only bi-annual measurements that are practical with traditional survey methods; providing far more reliable estimates of erosion and accretion trends in the shoreline. A

meeting of the *Rijkswaterstaat* in 2004 concluded that, "*Argus (video) has a future in Rijkswaterstaat for coastline management and obtaining knowledge of the nearshore - using CSIs measured with Argus (video) for the evaluation of nourishment and nourishment design*" (see section 5, I5). *Rijkswaterstaat* benefited by having a more effective way of managing their coastline and *WL Delft* benefited by having a more marketable and useful product.

Santander Port Authority, waterway managers for the international port, benefited from new methods for monitoring and managing the dredging operations in entrance to the Santander Harbour. The University of Cantabria and the CPRG developed a CSI that monitored the position of dynamic navigation channels, which is now used to trigger the realignment of channels via dredging, or repositioning navigational markers. This facilitates cost-effective dredging activities and safe navigational access to ports, benefiting industry, by ensuring the safe passage of commercial freight, boat crews, through ease of navigation and passengers, through reduced risk of ships running aground.

The UK *Environment Agency,* national managers for UK coastlines, benefited from new methodologies for monitoring and managing the coastal environment. As stated by the UK *Environment Agency* "*Impacts of this work (CPRG video research) are far ranging from aiding safe navigational access of vessels into harbour entrances and managing shipping channels to monitoring coastal erosion and management of coastal defences for public safety and risk reduction."*

Their direct involvement in CoastView led to the installation of coastal video systems at Chiswell and West Bay in Dorset to monitor coastal erosion and overtopping and to aid the timely intervention with beach replenishment. CPRG were consulted to assist with programming the system to record data suitable for quantitatively monitoring the coastline and protecting ***coastal*** residents and industry from flooding (I6).

Working closely with CoastView partners (*Deltares*), Davidson and Kingston (PU Lecturer 2000-present), developed user-friendly software for the analysis of video images (The Argus Runtime Environment) and the extraction of coastal state indicators (I4). Stephen Aarninkhof (senior scientist and engineer for *Deltares*) acknowledges the contributions of the CPRG to the development of the Argus Runtime Environment and their contribution to training coastal managers and scientists. He states "*work completed within the CoastView project has made coastal video systems more attractive in the global market place*" (I2). The systems and software are now commercially available through *Deltares* (I8) to scientists and coastal zone managers worldwide.

Uptake of the technology has increased greatly, from the installation of the first UK system in 1996, to ten UK systems by 2010. At least six of these systems have been wholly or part-funded by local council initiatives, e.g. *Teignbridge District Council,* the *Channel Coastal Observatory* (Slapton & Perranporth), *New Forest District Council* (Milford-on-sea), *Bournemouth Borough Council* (Boscombe) and *Wyre District Council* (Cleveleys). These systems were implemented for the benefits of improved navigational safety and management (Teignmouth), coastal protection from flooding (Slapton, Cleavelys, Chiswell and West Bay), beach safety (a rip-current waning system at Perranporth) and monitoring the coastal response to an artificial surfing reef (Boscombe).

5. Sources to corroborate the impact (indicative maximum of 10 references)

I1. Factual Statement from the Environment and Performance Manager for the UK Environment Agency.

I2. Factual statement from former Engineer for Delft Hydraulics now at EcoShape.

I3. Factual Statement from Coastal Specialist within the Shoreline Management Group of the UK Environment Agency, now Project Engineer for BMT Consultants.

I4. Argus User Manual: Algorithm, software development, demonstration and training for scientist

and coastal managers: Developed jointly between the CPRG (Kingston) and WL Delft Hydraulics for training new users of the technology. This was used in training workshops for scientists and coastal zone managers in the UK (Hosted by CPRG in Plymouth, September '02), Spain, Italy and the Netherlands (2-3 April '03). Software guide and training manual: http://141.163.79.209/CoastView/manualArgusTools2002b.pdf

I5. CoastView Final Report: volume 1. Uptake and application: CPRG's co-ordination of CoastView led to close involvement and interaction between scientists and national-scale coastal managers and coastal video research being integral to their policy for monitoring the coastal environment. A full list of dissemination activities can also be found on pages 7-13 and 27-43. http://141.163.79.209/CoastView/finalreportvol1.pdf

I6. UK Environment Agency Report: The EA commissioned a non-specialist video system to monitor the sensitive areas of the Dorset coastline around West Bay and Chiswell. The CPRG were consulted to improve the resolution of their system and to initiate a data-capture and archiving system that would facilitate the quantitative assessment of coastal stability and trends. Details are in: *Quantitative analysis of video data at West Bay and Chiswell* and *A provisional report on the feasibility of archiving and quantitative analysis of video data derived from existing systems at West Bay and Chiswell*: http://141.163.79.209/EA/ENV-03-2008-01.pdf; http://141.163.79.209/EA/ENV-03-2008-02.pdf

I7. CoastView Summary CD: This CD was widely distributed to scientist and coastal managers across Europe to promote the use of coastal video systems in coastal zone management with examples of how the technology is being used at the different sites around Europe following the CPRG led CoastView project. http://141.163.79.209/cd/index.html

I8. *Deltares* web pages advertising Argus Coastal Video Systems: Uptake and application of coastal video systems: Deltares (formerly WL Delft) were directly involved in the CoastView and benefited directly from the development of the technology within the framework of the project and the international dissemination of the project outcomes: http://www.deltares.nl/en/product/810105/argus