OIRTHIRSAT: KEEPING TABS ON COASTAL CHANGE

AN AWARD-WINNING REMOTE SENSING SATELLITE NO BIGGER THAN A TUBE OF PRINGLES LOOKS SET TO GIVE THE UK A VALUABLE NEW TOOL WITH WHICH TO MONITOR CLIMATE CHANGE. FREYA MUIR AND JOE GIBBS OUTLINE THE CHALLENGE AND REVIEW PROGRESS

The UK's coasts are changing rapidly every year with rising sea levels and increased storm activity. But a group of students at the University of Glasgow are taking to the skies to help solve these mounting coastal problems.

Coastal environments are highly dynamic regions with lots of complex, interlinked processes taking place. Despite this dynamism, an estimated two fifths of the world's population now live at or near the coast. The Intergovernmental Panel on Climate Change (IPCC) has identified that global mean sea level is now rising at double the rate it was in the 1900s.

Even if we achieve the strictest currently-set emissions targets and keep global warming below 1.5ºC, the damage has already been done to the delicate balance of coastal processes. Sea levels are predicted to continue to rise over the next century, from 0.3–0.6 m for 'best-case scenario' emissions and 0.6–1.1 m under a 'do nothing, business as usual' approach.

Impact and cost

The rise in global sea levels is causing a range of impacts to coastal environments and local communities. Low-lying coastal regions are being permanently submerged under higher tides; coastal flooding is increasing in intensity and frequency; the rates and extents of erosion are increasing, and ecosystems are changing or failing to survive under these rapid environmental shifts. These environmental changes lead to damage and destruction of buildings and utilities, widespread economic losses, displacement of settlements, and even loss of life.

Coastal communities with less space to move and accommodate these changes, or with less money to invest in mitigation and adaptation measures, will suffer as sea levels rise, shores erode and coasts flood.

Coastal managers and policymakers require up-to-date information on how coasts have been changing and may change in the future, in order to properly inform their decisions. One technique for measuring this change is to track the position of the water's edge. By measuring shifts in the shoreline position over time, changes to both the beach surface and the water level can be ascertained. However, getting down to the zone between low and high tide to measure an ever-moving edge like the shoreline can be very expensive and logistically difficult, leading to irregular surveying schedules. Despite this difficulty, shoreline positions remain a valuable measure of coastal change.

In one such survey, the Scottish Government's Dynamic Coast project measured the trends of past shoreline positions across Scotland from historic Ordnance Survey maps. This data was then used to inform a model of future coastal retreat under different rises in sea level. Under a high emissions scenario, the model predicted the cost of damage to Scotland's coastal infrastructure at up to £1.2billion by 2050. However, the amount of retreat or advance predicted was highly sensitive to those past rates of change. The project showed that there is still a clear requirement for fast, regular observations of coastal change at a UK-national scale.

Partial solution

Satellite-based Earth Observations offer a partial solution to the requirement for coastal data. Missions such as Sentinel and Landsat provide us with freely available, regular observations of the Earth's surface, with Landsat coverage stretching back in time to the mid-1980s.

As valuable as these resources are,

Satellite imagery can be processed to extract shoreline position changes at important coastal sites, such as seen here at St Andrews Golf Links and at Leuchars Airport

extracting coastal information from them is still site-specific and user-driven. An analyst must have some level of expertise in programming and in downloading and processing satellite imagery, as well as enough time and money to set up a new site for observation.

Even with the efforts of the Coastal Channel Observatory in parts of England and Dynamic Coast in Scotland, the UK still lacks a holistic, centralised portal for tracking how our coasts are changing nationally.

Affordable alternative

This is where OirthirSAT (see lead picture on preceding page) comes in, Oirthir being derived from the Scottish Gaelic for coast. Nanosatellites, like the OirthirSAT mission designed by University of Glasgow students, have recently become a more affordable and customisable alternative to larger-scale

A render of the OirthirSAT nanosatellite platform over the UK. The quasi-rhombic design of the drag sail (pictured top right) and its deployment mechanism offers a low-cost, versatile and sustainable solution for de-orbiting and attitude control of the satellite

Above left: The team working on the OirthirSAT mission is pictured (from L-R): Ignacio Serrano Martín-Sacristán, Joe Gibbs, Natalia Ibagón Sánchez, Theodoros Serghiou, Diego Hidalgo De Las Heras, Civan Doğan, Gregor MacAskill, Georgios Titas, Freya Muir, Nektarios Chari. Above right: Accepting the LaunchUK award from ESA astronaut Mattias Maurer at this year's Farnborough International Airshow

commercial platforms. These satellites, which are often no larger than a Pringles tube, can be loaded with off-the-shelf components and customised like Lego blocks.

The cost of building and testing these platforms is massively reduced, and their orbits can be designed specifically for the type of data needing to be captured (rather than a one-size-fits-all approach of larger multinational platforms). Nor does the captured data suffer many limitations: for example, the SimeraSense xScape50 multispectral image which is a 10cm cube can capture the same pixel resolution as the Landsat 8 payload.

The OirthirSAT team noticed this gap in national, rapid, easily understandable observations of our coasts and sought to fill it with an innovative nanosatellite design. By utilising novel techniques of onboard processing and Machine Learning, the same processes that are currently performed on the ground to automatically trace the shoreline in a satellite image could be done right there in Space.

By only relaying back shoreline positions instead of raw imagery, a significant amount of time and money could be saved on downlinking. Coastal managers could get national-scale, easy-to-use data faster and more regularly and, in turn, identify areas more at risk of coastal damage ahead of winter storms.

Winning proposal

The 10-strong team worked hard through winter exams and Christmas holidays to submit a proposal to the UK Space Agency's LaunchUK Nanosat Design Competition … one set up to introduce young people to the world of small spacecraft mission design. If successful, the winning team would be awarded up to £600,000 of funding and extensive mentoring to design, build and test its nanosat platform.

A main stipulation of the competition was that the design should address the UK's strategies for climate change mitigation and adaptation. This was the perfect opportunity to see a platform launched specifically to monitor coastal change as Britain's sea levels continue to rise.

42 teams from across the UK submitted their proposals in January 2022, and of the five shortlisted, OirthirSAT was the only submission from a Scottish team. However, the team itself is international, with members hailing from seven different countries, all of whom currently call Glasgow their home.

The winners of the funding competition were announced in an exciting awards ceremony at the world-leading Farnborough International Airshow in July 2022. After months of deliberation, the European Space Agency astronaut Matthias Maurer took to the stage at the Pioneers of Tomorrow event to announce that the OirthirSAT proposal had blown away the impressive panel of judges with its intelligent design and engagement with key stakeholders. The OirthirSAT team is going to Space!

Knuckling down

Now that the team has recovered from the excitement of Farnborough, it's a case of knuckling down and honing its design with the help of the UK Space Agency and BryceTech, an engineering firm that will help with procuring parts for the spacecraft.

Launch is scheduled for mid-2024, but there are milestones to be met before that point, including passing the Critical Design Review and Operational Readiness Review.

The team is confident, however, that its coastal boundary data will be beneficial to scientists and policymakers alike and help prepare and protect the vast majority of people and businesses located along the 2,000-mile length of Britain's coastline.

For more information, and to follow the team's journey, please visit https://www.oirthirsat.space/ and https://www.instagram.com/oirthirsat/

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