UAV Monitoring of Coastal Erosion

In this case study, QuestUAV describes the use of UAV photography and photogrammetry to measure long-term erosion of the coast of northeast England. The British Geological Survey states that across England and Wales 113,000 residential properties, 9,000 commercial properties and 5,000 hectares of agricultural land are within areas at risk of coastal erosion. Mitigating the effects of climate change requires coastal protection studies and coastal protection measures. As every planner knows however, this increases the burden of allocating ever decreasing financial resources.

Accurate evaluation of the change, gleaned from historical studies, combined with best practice from current studies and environmental factors allow the most effective and efficient decisions to be taken for coastal protection.

Drones for Coastal Surveys

Drones or Unmanned Aerial Vehicles (UAVs) are a great platform for monitoring the stability of a coastline and for carrying out a rapid initial survey after a storm. They can be used to quickly survey potentially difficult and dangerous large sites with a very high level of detail. Erosion monitoring, assessment of cliff stability, monitoring coastal vegetation and changes in land volume or coastline state are only a few examples of the applications for UAVs in coastal areas.

Other coastal applications include rapid pre- and post-storm assessments to quantify storm impacts, property monitoring for insurance purposes, monitoring coastal sand mining activities (cement), habitat monitoring through sea colour surveys, breakwater inspections and geological cliff and rock surveys.

QuestUAV has always had a special interest in using drones for coastal applications. Their main facility is located in a port town in the northeast of England on the shores of the North Sea. The environment there is harsh – wind and weather re-shapes the coast daily. The conditions in which UAVs have to perform are challenging, but have guided the company in creating one of the most stable fixed-wing UAV platforms on the market.

QuestUAV's sound airframe design includes a sensor gimbal to ensure high quality sharp images, even in turbulent conditions of wind speeds up to 65 km/h. With the latest PPK (post processing kinematic) technology on board, the drone enables survey mapping with a spatial accuracy of 2cm without the need for ground control points. PPK is particularly valuable for coastal work where it is not easy to find good positions for ground control.

Monitoring the Northumberland Coast

QuestUAV started monitoring the local coast of Northumberland between Alnmouth and Cresswell, designated an Area of Outstanding Natural Beauty in 2008. Since then, the coastline has been hit by two exceptionally strong flood events – one in November 2013 and one recently, on 13 January 2017.

Immediately after the latest storm, a QuestUAV crew flew the local coast, assessing the impact of the floods on the basis of the long-term image series. The assessment workflow involved a correlation of information from historical sources, satellite imagery and 3D modelling. The survey concentrated on the less protected dune land, especially to see how much property owners had lost from erosion.

The flight crew flew the site with a Q-200 PPK drone at 400 feet and the subsequent photogrammetry achieved centimetre-level accuracy without the need for ground control. The imagery resolution was 2.9cm, GSD (ground sampling distance).

Time-series Images

Calculations showed that approximately 850 tonnes of dune and dune-foot were lost along an 80-metre stretch of coastline and the high water mark receded by up to 2.2 metres at the most critical point. The expected slumps that will happen as a result of erosion at the toe are estimated to carry a further 300-tonne loss within 12 months. To see the long-term development of the coastline, a flight from January 2013 was also included in the analysis. The storm event in November 2013 had an impact comparable to the latest flood, but fortunately, sand, stones and organic matter deposits along existing structures and the coastline are replaced, to an extent, over the years.

PPK or RTK

Generally, there are three ways to achieve high spatial accuracies:

1. Combining image data with Ground Control Points (GCPs)
2. Correcting position information by means of post-processing kinematic (PPK) systems
3. Correcting position information by means of real-time kinematic (RTK) systems

The great advantage of PPK over RTK is that PPK systems do not require a real-time data link with a fixed reference station while still guaranteeing centimetre-level position accuracy. This simplifies the entire set-up, and reduces the requirements and power drain of the GNSS receiver on board the drone.

PPK systems eliminate the risk of losing data due to unreliable radio links between drone and base station, which often plague drone operations based on RTK workflows. The base station may be a receiver set up on a tripod at the site to record data during the drone flight or, for many countries, data downloaded from a national CORS network station can be used instead.

With both RTK and PPK, when the receiver on the drone loses lock, a new integer ambiguity resolution procedure must be initiated. The advantage with PPK is that the search can proceed from previous and future data relative to that instant, whilst RTK solutions cannot use data that has not yet been recorded.

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