Introduction

There is an emerging consensus that we cannot solve the climate crisis by taking action on land alone. We must rapidly bring the ocean into efforts to rebalance the global carbon budget. The ability of coastal mangroves, seagrass and saltmarsh to store carbon is becoming increasingly recognised, but the role of these habitats in mitigating climate change is ultimately limited by their small area, less than 0.2 percent of the global ocean. Continental shelf seabed habitats, in contrast, cover at least 38 times more space but we have little idea of the carbon sequestering capacity of these vast areas and the extraordinary fauna and flora that lives on them, and there is no hard evidence of how managing the seabed differently could increase carbon storage.

Recent estimates suggest that coastal waters and continental shelves could provide six percent of the carbon drawdown needed to slow the rise in global temperatures to 1.5 degrees Celsius – the same impact as closing the world's cement and chemical industries – but the data is insufficient and inconclusive. The sea is, therefore, critically undervalued and overlooked. Two things are certain: we cannot solve the climate crisis without the ocean and, there is a huge need for empirical data to prove how the seascape stores carbon.

Blue Marine Foundation (BLUE), the University of Exeter and Convex Group Limited have partnered on an ambitious, five-year global research programme that will provide critical data and insight on what the world needs in order to fully incorporate the ocean into efforts to slow climate change. It builds on two highly successful, high-profile science programmes that supplied incontrovertible evidence that climate change was already the cause of major disruption: The Catlin Arctic Survey, and the Catlin Seaview Survey. The former demonstrated the alarming thinning of Arctic sea ice, while the latter global health check on coral reefs showed serious, widespread degradation and decline in the face of global warming.

The Convex Seascape Survey turns the focus onto an immense but neglected and misunderstood region of the ocean – the continental shelves – which could be a crucial ally in action against climate change. This programme represents a natural fit for Convex. Like many of its customers and peers, Convex is acutely aware of the growing impact of climate change and the risks associated not only with its physical consequences, but also with the scale and rapidity of transition. As an insurer, Convex's business is about managing risks, which means that robust data sources have enormous importance. For this reason, Convex, working with BLUE and the University of Exeter, has identified the need for a significantly greater understanding of the properties and capabilities of the ocean and seabed in the Earth's carbon cycle.

The Convex Seascape Survey brings together the interdisciplinary depth, global reach, bold ambition and resources needed to tackle such a challenge. Over the course of five years, it will undertake sixteen major expeditions across the world, employing satellites, drones, ship-based sampling, submarines, remotely operated underwater vehicles, scuba, and high-powered computers. The Survey will provide timely, accurate, open-access data on the world's shelf seabed carbon stores, giving them long-overdue international attention and prominence.

Key scientific objectives

Seascape carbon – where is it, how and when did it get there and where did it come from?
We will identify the origins of carbon on the world's continental shelves and explore how it has accumulated and altered over time, discover where the biggest stores are located, molecularly fingerprint where they came from, and put the size of these carbon stores into context in the global carbon cycle.

Human influences on seascape carbon
We will map the spread of the various human activities that have been disturbing the seabed over the past two and half centuries. By overlaying disturbance maps with our maps of the distribution of carbon in the seascape, and experimental measures of the consequences of bottom disturbance in the field and laboratory, we will identify historic and contemporary patterns of human influence on blue carbon and determine its vulnerability to loss and re-release to the ocean and atmosphere. We will thereby make quantitative links between human pressures on the seascape and their impact on carbon dioxide emissions and identify potential management options to slow climate change.

The role of life and biodiversity on seascape carbon stores
We will study and monitor the effects on wildlife and habitats of protection from seabed-disturbing human influences at multiple representative locations worldwide. We will measure how long it takes for carbon capture and burial to recover following protection and quantify the complementary benefits of protected areas to wildlife and people, in terms of ecosystem services, economic benefit and increased human wellbeing.

Delivery partners

The project will be managed by BLUE with the scientific leadership of Professor Callum Roberts and the University of Exeter. The Convex Seascape Survey has been developed by an interdisciplinary team of international experts, whose research strengths cover many fields, including marine ecology, oceanography, geology, history, satellite telemetry, remote underwater monitoring, environmental science, cartography, chemical and molecular analyses, and Earth systems modelling. The core team has field experience from pole to pole, taking in Antarctic, Arctic, temperate and tropical seas.

Other core partners
King Abdullah University of Science and Technology (KAUST): Overseas field research and advice on overall project design, sampling and analyses.
University of Utrecht: Sample analyses and expertise on the coastal shelf carbon cycle.
National Oceanography Centre, University of Southampton: Lab-based experiments on how seabed organisms capture and store carbon and how human activities disrupt these processes.
Plymouth Marine Laboratory (PML): Field investigation of the interaction of fishing gears with seabed life.
Sheffield University: Data mining and synthesis of the structure of the seabed to find places most likely to accumulate carbon.
Bangor University: Oceanographic modelling to predict the distribution and accumulation of seabed carbon stores and their response to global change.

Work programmes

WORK PROGRAMME ONE: The where, when, how and what of blue carbon in the seascape
Understanding seabed carbon deposition and accumulation through history and into the future.

Task 1.1: Data mining and synthesis.
Task 1.2: Oceanographic modelling to predict carbon accumulation.
Task 1.3: Field research to sample carbon in seabed sediments and test model predictions.
Task 1.4: Tracing the origins of blue carbon inputs to the seabed carbon sink.
Task 1.5: Placing sediment carbon into context of global carbon.

WORK PROGRAMME TWO: Human influences on seascape carbon
The recent period of human global influence and domination of the planet has come to be known as the Anthropocene. In programme two we will explore the Anthropocene Seabed, documenting how human influence has grown in the ocean and shaped the seascape.

Task 2.1: Historical development and spread of human influences on the seabed.
Task 2.2: Contemporary intensity and distribution of bottom disturbance by human activities.
Task 2.3: Where are the world's remaining areas of pristine/intact seabed habitat?
Task 2.4: Viewing the impact of seascape disturbance from space.
Task 2.5: Measuring the impact of trawling on sediment carbon and animals from within the water.
Task 2.6: Quantifying the global impact of seascape disturbance on sedimentary and atmospheric carbon.

WORK PROGRAMME THREE: Life and biodiversity effects on blue carbon capture and burial, and benefits of protection
Understanding how seascape protection recovers wildlife, rebuilds habitats, restores their blue carbon values and delivers wider economic and wellbeing benefits to human society.

Task 3.1: Monitoring and measuring uptake of carbon by seabed habitats and recovery of carbon stocks after protection.
Task 3.2: Laboratory mesocosm experiments to measure how animals take up and store carbon under different conditions.
Task 3.3: Evaluating the co-benefits of seabed protection from human impacts on wildlife and ecosystem services.
Task 3.4: Economic values of protection.
Task 3.5: Measuring, monitoring and minimising the project's carbon and environmental footprint.

WORK PROGRAMME FOUR: Communications and outreach
Communicating and helping the general public visualise this project is key to its success. Work programme four will showcase scientific findings and project progress through media and live education outreach sessions.

Task 4.1: Development of communications plan and assets.
Task 4.2: Development and creation of digital platform.
Task 4.3: Deliver outreach.
Task 4.4: Secure exclusive programme media partners.
Task 4.5: Conduct press campaigns with announcements.
Task 4.6: Promote conclusive results to create a legacy.