PART 1

Read the text below and answer questions 1–13.

BLUE CARBON: THE OCEAN'S HIDDEN CLIMATE SOLUTION

Blue carbon is the term used for carbon captured and stored by coastal and marine ecosystems—most notably mangrove forests, salt marshes, and seagrass meadows. The concept is sometimes contrasted with “green carbon” in terrestrial forests, but the distinction is not simply about colour; it is about where carbon ends up and how long it stays there. Although these coastal habitats occupy only a small fraction of the Earth’s surface, they can exhibit unusually high storage density because much of their carbon is deposited below ground, where it can remain for centuries. This has made blue carbon attractive within climate policy as a nature-based option that can contribute to mitigation while also improving shoreline stability, biodiversity, and fisheries.

The durability of blue carbon is largely explained by the chemistry of burial. In mangroves and marshes, leaves, roots, and detritus are trapped by dense vegetation and accumulate in *waterlogged sediments*. Because these sediments are saturated and often saline, oxygen is limited and microbial decomposition slows under anaerobic conditions. As plant material becomes buried, carbon is effectively biosequestered, sometimes persisting for millennia, especially where sedimentation rates are high and disturbance is low. This mechanism differs from many terrestrial systems, where a larger share of carbon is held above ground in trunks and branches and can be rapidly released by wildfire, logging, or drought-induced dieback. The point is not that land-based solutions are trivial, but that coastal sediments can act as exceptionally stable carbon vaults per unit area when conditions remain intact.

That stability, however, is conditional rather than guaranteed. Blue carbon ecosystems are vulnerable to anthropogenic disruption because their stored carbon is concentrated in sediments that can be physically disturbed. When mangroves are cleared for coastal development or aquaculture, or when marshes are drained and converted, oxygen penetrates layers that were previously anaerobic. Microbial activity can then accelerate, and stored carbon may be released back to the atmosphere as carbon dioxide and, in some settings, as *methane*, a greenhouse gas with a high warming effect. In addition, dredging, pollution, and altered freshwater inflows can degrade habitat health, weakening plant growth and reducing future carbon accumulation. Climate change itself adds pressure through sea-level rise, stronger storms, and marine heatwaves that can stress seagrass, damage root systems, and destabilise sediments.

Because losses can be large and rapid, restoration is often presented as an obvious remedy, yet practical outcomes are mixed. Successful projects require more than planting seedlings; they depend on restoring the physical conditions that allow an ecosystem to function. For mangroves, replanting can fail if channels have been blocked or if the tidal regime has been modified. In salt marshes, recovery may require reintroducing tidal flow through culverts or managed realignment, ensuring that sediment supply and inundation patterns match the vegetation's tolerance. For seagrass meadows, re-establishment is strongly limited by water clarity, turbidity, and nutrient loads; if runoff continues to drive algal blooms, transplanted shoots may die even when initial planting appears successful. In many cases the key constraint is *hydrology*: if water movement, salinity balance, and sediment dynamics are altered, biological recovery becomes fragile or temporary.

The scientific challenge of measurement complicates these restoration debates. Blue carbon is not easily assessed from the surface because the largest reservoir is often below ground. Sediment cores must be collected, processed, and analysed to estimate carbon content over depth and time, which is labour-intensive and expensive. Moreover, accounting frameworks must consider greenhouse-gas trade-offs. In some wetland settings, methane emissions can offset part of the climate benefit, so a simple "carbon stored" figure can be misleading if other gases are ignored. Because uncertainty is high and site conditions vary, many researchers recommend conservative *accounting* approaches that avoid over-crediting projects. Some argue that, from a risk-management perspective, protecting existing intact habitats may be more reliable than claiming large credits from newly planted areas whose long-term survival is not assured.

Policy interest has nevertheless expanded rapidly, partly through carbon markets and partly through national climate commitments. Some countries have begun to include mangroves and marshes in emissions inventories, and project developers may seek credits if they can demonstrate additionality, permanence, and robust monitoring. Yet blue carbon markets raise familiar concerns: verification can be difficult; leakage can occur if protection in one area shifts destructive activity elsewhere; and equity problems can arise if conservation measures restrict local livelihoods. Critics warn that poorly designed projects might reduce community access to fishing grounds or fuelwood, or intensify land tenure conflicts, especially where coastal governance is weak. Supporters counter that with clear rules and local participation, credits can finance restoration and enforcement that would otherwise be unaffordable.

Beyond mitigation, blue carbon ecosystems provide adaptation benefits that are often easier to observe than buried carbon stocks. Mangrove roots and marsh vegetation attenuate wave energy, reducing storm-surge impacts and protecting infrastructure. By

stabilising soils, these habitats can limit shoreline retreat and slow *erosion*, which is particularly valuable as sea levels rise. Seagrass meadows can trap sediments, improve water quality, and support nursery habitats for fish, linking climate policy to food security. These co-benefits strengthen the case for investment even when carbon measurement is uncertain, because the protective functions can deliver immediate value to coastal communities.

The future of blue carbon therefore depends on aligning science, governance, and incentives. Coastal habitats sit at the land–sea boundary, where responsibility is often fragmented across agencies for fisheries, planning, conservation, and development. Effective policy requires coherent land-use planning, enforcement against illegal conversion, and long-term maintenance rather than short-term planting campaigns. It also requires realistic expectations: blue carbon can complement emissions reductions, but it cannot replace them. At its best, protecting and restoring coastal ecosystems offers durable sediment storage alongside biodiversity and coastal protection—especially when projects are designed around local conditions, credible measurement, and community participation.

Questions 1–4

Select the correct answer.

1 What does the passage suggest is a key reason blue carbon storage can be long-lasting?

A Coastal ecosystems store most carbon only in fast-growing leaves.
B Carbon can be buried in low-oxygen sediments where decomposition is slow.
C Coastal wetlands avoid carbon loss because they are never disturbed by humans.
D Blue carbon is mainly stored above ground and can be replaced quickly after damage.

2 What risk is mentioned when mangroves are cleared or marshes are drained?

A Stored carbon can be released as carbon dioxide and methane.
B The carbon stored in sediments becomes permanently inaccessible to the atmosphere.
C Clearing wetlands prevents methane from forming in coastal environments.
D Climate change effects on seagrass are eliminated once wetlands are restored.

3 Why does the passage describe restoration as complex?

A Restoration depends mainly on planting seedlings, regardless of local conditions.
B Restoration is unnecessary because protection alone is always sufficient.
C Recovery depends on factors such as hydrology, tidal flow and water clarity.
D Restoration projects are not allowed to claim any climate benefits.

4 What is said about carbon markets for blue carbon projects?

A They are generally free from concerns about verification and permanence.
B They ensure coastal communities benefit equally from conservation initiatives.
C They eliminate the need for community participation in project design.
D They raise issues such as verification, leakage and equity.

Questions 5–9

Complete the table below. Choose **ONE WORD ONLY** from the text for each answer.

Blue carbon: processes, constraints and benefits

Area	**Process / Condition**	**Effect / Comment**
Carbon storage	Plant material accumulates in waterlogged **5 .....**	Limited oxygen slows microbial decomposition
	Clearing, drainage or other disturbance	Stored carbon may return to the atmosphere as carbon dioxide and **6** .....
Restoration	Local **7**	Altered water movement, salinity or sediment dynamics can prevent lasting recovery
Measurement	Sediment cores and greenhouse-gas assessment	High costs and uncertainty support conservative accounting **8 .....**
Policy and finance	Carbon-market projects	Verification, permanence, leakage and community equity require attention
Coastal adaptation	Mangrove roots and marsh vegetation reduce wave energy	Shoreline retreat and **9** ..... are limited
	Seagrass meadows	Trap sediment, improve water quality and support fish nurseries

Questions 10–13

Choose **TRUE** if the statement agrees with the information given in the text, choose **FALSE** if the statement contradicts the information, or choose **NOT GIVEN** if there is no information on this.

10 The passage suggests that blue carbon habitats cover a small area but can store large amounts of carbon.

11 The passage states that seagrass recovery depends on water clarity and nutrient conditions.

12 The passage claims that blue carbon can replace the need for rapid emissions reductions.

13 The passage specifies the exact proportion of global emissions that blue carbon projects could offset.

Answer Key

1. B
2. A
3. C
4. D
5. sediments
6. methane
7. hydrology
8. approaches
9. erosion
10. TRUE
11. TRUE
12. FALSE
13. NOT GIVEN