Paper 2 Physical Options

UNIT 2 Coastal environments

Recommended Prior Knowledge As is the case for all the Advanced Geography Options, completion of the Core is expected. The Coastal environments option builds on knowledge and understanding gained in the compulsory core Unit 3 Rocks and weathering.

Context The focus here is on the links between process and form and the ways in which human activity is impacting upon coastlines. Examples may be taken from any part of the world, but knowledge of coral reefs is mandatory.

Outline Knowledge and understanding of coastal processes should precede study of the landforms produced by these processes along cliffed and constructive coasts. 2.1 and 2.2 are interlinked in this option as teaching of the relevant process ideally precedes introduction of the landforms. Hence erosional processes precede cliffed coastlines and transportation and deposition precede constructive coastlines. Detailed knowledge of coral reefs is required as is appreciation of the role of human activity in the coastal environment. To exemplify the problems of sustainable management, one or more stretches of coastline may be chosen.

New recommended text Hordern, R (2006*) Rivers and Coasts* Philip Allan Updates

Content	Objectives and suggested teaching activities	Online resources	Other resources
2.1 Wave, marine and sub-aerial processes	**Waves** **Definition of a wave** Waves are oscillation of the water surface. Make the point that the water does not move forward. **Wave terminology** wave height, length, frequency, crest, trough. This can be done by means of a diagram. **Formation and size of a wave** 1. Wind velocity 2. Depth of water 3. Fetch i.e. the distance that the wind has travelled across the water surface, influences the nature of the wave. Waves possess energy, therefore have the ability to carry out processes.	www.geography@btinternet.co.uk is the best web site for links. Highly recommended for all aspects of coasts. www.s-cool.co.uk also has links. The other best source is Geofile Online from Nelson Thornes. Reference will be made to specific articles where relevant.	Waugh pp.141-2 Nagle p.106 Guinness and Nagle p.293 Bishop and Prosser p.59 has an excellent diagram. Bishop and Prosser p.60

	Zones – breaker, surf and swash. **Breaking waves** Waves break when the water depth is too shallow to support the whole oscillation. **Swash** Forward movement of water up the beach, **Backwash** movement of water down the beach. Relative strength of the two influences the nature of the wave. **Constructive waves/swell waves** Swash is greater than backwash – large fetch, long wave length, low height, found on low gradient beaches, low energy waves which **deposit** material. **Destructive waves/storm waves** Backwash is greater than swash – short fetch, short wave length, high waves and frequency, found on steeply sloping beaches, high energy waves which **erode**. Low energy coasts. High energy coasts. **June 2002 Q. 3(a)** **Wave refraction -** link to headlands and bays. Variations in water depth - deeper water around headlands, concentration of erosion whereas deposition in bays. Wave refraction off the end of a spit **-** link to deposition and recurved ends of the spit. **June 2008 Q. 3(a)** **Relationship between wave type and beach profile** Candidates should understand the relationship between the two wave types and beach profiles. Explain how beaches may be in a state of dynamic equilibrium because the steeper profile produced by swell waves will cause destructive waves which comb material down the beach and may deposit if offshore. This will reduce the gradient of return to constructive waves. Will introduce ideas of erosion, transportation and deposition of material. Beach	**June 2008 Fig. 2 Q. 4** useful teaching aid. **Nov 2006 Q. 3(a)** **June 2006 Fig. 2** **June 2008 Q. 3(a)**	Bishop and Prosser p.60 Waugh pp.144-5 Nagle p.107 Guinness and Nagle p.294 Bishop and Prosser p.61 Nagle p.107, excellent diagrams. Bishop and Prosser p.89 has a well annotated diagram.

	profiles may show significant variation between the stormy seasons and less stormy seasons due to variations in wave energy and dominant wave type, linked to wind direction. **November 2002 Q. 4(a)** has a diagram which is an excellent teaching resource. **June 2005 Q.3(a)**		Bishop and Prosser p.67 Christchurch Bay Hampshire, UK, as an example. Nagle p.113 good diagram of a sediment cell.
	One approach to the study of processes is via the **sediment cell**. A unit of study which considers a section of coastline in terms of an 'open' system and dynamic equilibrium between erosion and deposition, sources/inputs and sinks/outputs, of sediment. See Fig. 2 for a teaching aid. **Sources of sediment**: weathered cliffs, beach material, offshore bars, river sediment, in-drift of material from adjacent littoral cell, beach nourishment. **Sinks**: offshore bar, beaches (could be in the form of a spit), sand dunes, out-drift to next sediment cell. Transport along the cell (LSD, longshore drift) current and tidal action within the cell. Cells are ideal units for study of coastal management - link to 2.4 and the landforms in 2.2. **June 2002 Q. 4(a**) has an excellent teaching resource in the form of a flow diagram. **Nov 2003 Q. 3(a)** the sediment cell could usefully be used as a framework for the answer.	**June 2004 Fig. 2 Q. 4(a)**, useful teaching tool. **June 2008 Q. 3(a)**	Digby (CE) p.113 - well linked to human activities 2.4 Cook, Hordern, et al. p.459, pp.468-73
	Marine processes Waves as agents of: **Erosion** **Hydraulic action or impact** i.e. the sheer force of the waves exerts a pressure which can be up to 30000kg/sq.m in storms. **Wave quarrying (cavitation)** is the compression of air in openings in the rocks at the coast as the wave hits. Decompression takes place as the wave recedes. This process weakens the structure and increases surface area for other forms of erosion. Therefore large blocks can be 'quarried' (removed from the cliff face). Also known as quarrying**. Corrasion/abrasion** in which the load carried by the breaking waves acts as a tool, rather like sandpaper, smoothing the rock. Important in producing the		Bishop and Prosser p.64 has a good explanation of wave quarrying. Waugh pp.149-150 Nagle p.109 good diagram. Guinness and Nagle p.297, excellent whole page diagram. Hordern pp.61-2

	notch at the cliff base and in shaping wave cut platforms. **Attrition** reduction in calibre of the load carried by waves as abrasion occurs between the particles. **Solution** is active in calcareous rocks like chalk and limestone where carbonation-solution creates soluble material which is carried away by the waves. **Nov 2002 Q. 3(a)** **June 2003 Q. 3(b)**	**June 2005 Q. 3(b)**	
	Landforms produced due to coastal erosion. **Cliffed coastlines** **Erosion** Evolution of a typical cliff profile: cliff, notch, abrasion/wave cut platform, beach. **Nov 2002 Q. 3(a)** **Cliffs** should be studied in **profile** (cross section) and **plan.** This is an important distinction which should be known. **November 2007 Photograph A for Q. 4**		Bishop and Prosser pp.79-80, example pp.81-3 Waugh p.151 Clowes and Comfort p.260, good diagrams.
	Form **Factors influencing cliff form:**		Cook, Hordern, et al. pp.473-5
	i. Sub-aerial processes of weathering and mass movement Detail about processes e.g. frost shattering, carbonation-solution, hydrolysis - those processes which typify the coast rather than weathering itself. Similarly with mass movement.	Geo Factsheet 129 The impact of structure and lithology on coastal landforms	Bishop and Prosser pp.70-9, good diagrams pp.74-5
	ii. Lithology and rock structure		Bishop and Prosser p.75
	iii. Isostatic and eustatic changes iv. Human activity		Bishop and Prosser p.74
	Simple form **Vertical cliffs** in massive resistant rock, e.g. chalk, limestone, granite. **Complex/composite form** **Mixed lithology**, which have undergone rotational slip.	**June 2005 Q.3(b)** **Nov 2006 Q. 3(b)** **June 2008 Q. 3(b)** A popular question on cliffed coastlines.	Bishop and Prosser p.74 Clowes and Comfort p.261, excellent photograph.

Swash aligned coasts Drift aligned coasts	**Slope over-wall cliffs -** actively eroded cliff base and a contrasting upper slope of 'dead'/degraded cliff between 5 and 50˚ which represents past periglacial processes when sea level was lower. Rise in sea level has produced new vertical cliff face. **November 2003 Q. 4(a) Diagram E** **Influence of dip of strata** – horizontal, vertical, seaward and landward dipping. **Active and inactive cliffs** - the latter are dominated by sub-aerial processes. **Shore platforms -** raised beaches and degraded cliflines, linked to sea level change. Development of spits may lead to degraded clifflines as wave attack is prevented. Annotation of photographs can be a useful exercise. Human activities may be introduced here, e.g. building on cliff tops may be a contributory factor in cliff collapse/rotational slip. **June 2003 Q. 3(b)** and **November 2003 Q. 4(a).** **Headlands and bays** and their relationship to lithology along a section of coast. Plan and headland profile: evolution of landforms produced due to erosion on the headland (deep water, wave refraction, concentration of erosion on the headland: caves, arches, stacks). Deposition: Having considered headlands and focused on erosion, the logical progression is into bays, and deposition, shallow water and breaking waves. **Marine processes** **Transportation** the direction of movement is related to direction of the prevailing wind and direction faced by the coast. Material may be carried up and down the beach if the prevailing wind is at right angles to the coast, or along beach if the wind approaches at an oblique angle. **Longshore drift (LSD)** Longshore currents may be important in bays where wave	**June 2005 Fig. 2 for Q. 4** useful diagram **June 2008 Q. 3(b)** Geo Factsheet Number 145 April 2003 Coastal deposition www.curriculum-press.co.uk **June 2006 Q. 3(b)**	Hordern pp.63-5 Waugh pp.151-2 Waugh p.153 Waugh p.143 Nagle p.116 (good diagrams) Guinness and Nagle pp.300-1 Bishop and Prosser p.86 Clowes and Comfort pp.278-9 Waugh p.154 Nagle pp.114-5 Guinness and Nagle p.301 Clowes and Comfort p.274 Bishop and Prosser pp.89-92 Bishop and Prosser p.94, case study of Start Bay, Devon, UK including Slapton pp.95-8

	refraction is significant. **Deposition**: if swash is greater than backwash - beaches are constructed/built up and if longshore drift is taking place then beaches are built along the shore. Coastal landforms of constructive coasts. **Beaches** should be studied in **profile** (cross section) and **plan**. Gradient, variation in calibre of material from cliff to low tide, storm beach, berm, offshore bar. Relate back to wave type - constructive/destructive and swell and storm profiles, 2.1. **Micro-features:** ripples, cusps, runnels. Formation of these features and understanding of processes operative to produce these small features. Beaches that develop due to longshore drift: **Spits** **Simple spit** is a fairly long narrow straight ridge of sand shingle with one end attached to the mainland and one end in open water. **Compound spits** which have laterals/recurved laterals. Evolution of spits. **June 2002 Q.3(b)** **Bars** A bar has both ends attached to the mainland. Usually has a lagoon behind it, e.g. Slapton Sands and Slapton Ley (lagoon behind the bar), Devon, UK. **Offshore bars** and relationship to spits and longshore drift. e.g. Chesil beach, Dorset, UK, in which offshore material deposited during the Pleistocene has moved inland as a result of the Flandrian transgression (post glacial rise of sea level). **June 2003 Q. 4(a) Fig. 2** good diagram of a spit to use as a teaching aid. **Tombolos**		Hordern pp. 67-73 Case studies of Porlock Bay and Holderness, UK. Bishop and Prosser p.94 Guinness and Nagle p.304 Waugh p.156, case study of Eastern seaboard of the USA. Guinness and Nagle pp.117-8 Clowes and Comfort pp.282-6 Waugh p.157 Nagle p.118 Guinness and Nagle pp.304-5 Guinness and Nagle p.307, case study of Scolt Head Island, Norfolk, UK. Bishop and Prosser pp.100-1 West Wales, UK. Case study of sand dunes and salt marsh. Waugh p.158 Nagle p.119 There are plenty of case studies which focus on depositional landforms and their sustainability link to 2.4

	Barrier islands relationship to offshore bars. **November 2003 Q.3(b)**		Nagle p.117 Bishop and Prosser pp.98-100
	Coastal sand dunes: formation, form and plant succession in relation to stabilisation of the sand. **Estuaries –** deposition, mudflats. **Salt marshes** may be considered in relation to spits and tidal sedimentation in estuaries. Plant succession in so far as the vegetation stabilises the sediment. **June 2002 Q. 3(b)** Throughout links can be made to 2.4. Human activity is relevant and important in influencing the stability and long term nature of these landforms. Depositional landforms in particular are unstable and fragile environments. **June 2003 Q. 4(b)**	**June 2006 Q. 4(b)** dunes and salt marshes	Hordern pp.80-6 very good section on sand dunes. Geofile 544 April 2007 Salt marsh Ecosystems Geo Factsheet 160 The Importance of Wetlands
2.3 Coral reefs	**Formation and Development** Understanding of a coral polyp - a single organism living in a symbiotic relationship with zooxanthellae/algae. Ability of coral to build reefs by production of calcium carbonate. Reef form related to algal variety. This is necessary basic understanding, although questions are likely to focus on reef form and theories of formation.		There is a wealth of information on coral reefs. *The Blue Planet* Richard Attenborough BBC publications Book and Video. Excellent section on the formation and forms of reefs, pp.108-9 Flintoff and Cohen p.32 Digby (CE) p.109 Warn p.6-7 Witherick and McNaught pp.73-4 Geofile 519 April 2006 Coral Reefs

	Conditions for growth of coral **Temperature** 23-25˚C; **Water depth** less than 25m but not exposed to air; **Light** for photosynthesis; **Salinity** required; **clean, clear water** sediment free; **well oxygenated water** produced by strong wave action. **Global distribution of coral** Tropical seas between Tropics of Cancer and Capricorn. Offshore, on eastern and western continental and island margins. **Forms of reefs** Fringing; barrier; atolls. Demonstrate links between the three forms. **June 2003 Q. 3(a)** and **November 2002 Q. 3(b)** includes theories of formation. **Theories of formation** Darwin, Daly and Murray. Darwin is the best documented and demonstrates the evolution from fringing through barrier to atoll. Limited spatial application. Will include causes and effects of sea level change on reefs - may link directly to human activity. Coral reefs would be an excellent example to use for sustainable management of a section of coastline, see 2.4. However, alone, a reef cannot exemplify all the aspects of human impact which require study, so it needs to be used in addition to one or more other case studies.	**June 2005 Fig. 2** an excellent series of diagrams ideal for teaching. **Nov 2006 Fig. 1 for Q. 4** Good map of the Great Barrier Reef. **June 2008 Q. 3(b)**	*The Blue Planet* p.105 Warn p.4 Gillett pp.68-70 Warn p.5 *The Blue Planet* pp.103-4 Warn p.5
2.4 Sustainable management of coasts	**One stretch of coastline** – this should be of manageable length i.e. not the whole south coast of the UK. A littoral cell is a useful unit for study. Ideally it includes both cliffs and depositional features resulting from longshore drift. Consideration of balance between natural processes and human influences. Management strategies. **Coastal protection measures** Hard and soft engineering, integrated planning e.g. SMPs (Shoreline Management Plans), government policy, managed retreat, 'do nothing'. Conflicts and local issues which may arise. Cost-benefit analysis of alternative protection measures. Sustainable management may involve more than coastal protection, i.e.	Geo Factsheet Number 141 Holderness Coast (UK) A study of coastal management www.curriculum-press.co.uk	

	zoning of human activities, marine reserves, limits on fishing. **A range of case studies may be considered more appropriate which illustrate particular threatened landforms** e.g. coral reefs, spits, salt marshes (see below). However, ideally, candidates should appreciate the balance of processes along a section of coastline and be able to evaluate the advantages and disadvantages of the possible solutions, which may involve both physical protection and human utilisation of a stretch of coastline. A coral reef coastline may not offer sufficient coverage of all aspects of this unit so that, whilst it exemplifies a coastal area under threat, the range of landforms is somewhat restricted and it is advisable to consider examples of other stretches of coastline, too. **November 2002 Q. 4(b)**, **June 2002 Q. 4(b)**, **June 2003 Q. 4(b)** protection of salt marshes, **November 2003 Q. 4(b)** Be careful about the use of textbook case study material which may not be familiar to the student. Start with a well labelled map so that they have a spatial context, try to find photographs as well. Maps can be a useful and time-saving means of describing a coastline in the examination provided the detail is included.	**June 2005 Q. 4(b)** **June 2008 Q. 3(b)** This question comes up frequently. **Nov 2006 Q. 4(b)** on fragility of coastal environments.	Bishop and Prosser Chapter 6 is devoted to Management of Britain's Coasts - excellent information on protection measures and strategies. Illustrated by Fairlight Cove (also covered in detail in Waugh pp.171-175) and Barton on Sea cliffs, Hampshire, UK. Also in Witherick p.61 Witherick p.60 has an excellent diagram of forms of human intervention along the coast. Nagle p.123, coastal protection at Portland, Dorset, UK. Guinness and Nagle Managing Dawlish Warren, UK, a spit, pp.302-4 Hordern Part 9 pp.87-113, highly recommended as it covers LEDCs and MEDCs. Digby (CE) features the human impact on coastal systems. Chapters 7 and 8 on the Northumberland coast, UK. Chapter 9 West Africa pp.118-121 Chapter 10 Managing Coral reefs, pp.135-143 Thailand.