CENTRAL SCHOOL

SPFSC

GEOGRAPHY

TOPIC:

NATURAL PROCESSES- COASTAL PROCESSES

CASE STUDY:

MELE COASTAL ENVIRONMENT

STRAND 1: Natural Processes in a Geographic Environment in the Pacific

Natural Processes: - Coastal Processes

Pacific Geographic Environment: Country: Vanuatu Local Area: Mele Bay

***Major Learning Outcome**: Students are able to demonstrate an understanding of a geographic environment in the Pacific, focusing on interacting natural processes*

Sub-strand 1.1 Interacting Natural Processes in a Geographic environment

Key Learning Outcome: Students are able to demonstrate an understanding of the different natural processes that operate in a geographic environment in the Pacific and how they have been modified by human action

	Specific Learning Outcomes (SLO)	Skill Level	SLO Code
1	Define natural process or high order process	1	Geo1.1.1.1
2	Identify a natural process or high order process	1	Geo1.1.1.2
3	Define elements of a natural process	1	Geo1.1.1.3
4	Identify the elements of a natural process or high order process	1	Geo1.1.1.4
5	Name the interacting natural processes that operate in a chosen environment	1	Geo1.1.1.5
6	Define local spatial variations	1	Geo1.1.1.6
7	Define temporal variations	1	Geo1.1.1.7
8	Identify/Name the natural features/phenomena that result from the interacting natural processes that operate in a chosen geographic environment	1	Geo1.1.1.8
9	Develop a map key for a sketch map to show the elements of any of the interacting natural processes that operate in a chosen geographic environment	1	Geo1.1.1.9
10	Develop a map key for a sketch map of the distribution of the resulting natural features from the interacting natural processes	1	G1eo1.1.1.10
11	Draw annotated sketch map to show the elements of any of the interacting natural processes that operate in a chosen geographic environment.	2	Geo1.1.2.1
12	Draw a sketch map to show the distribution of the resulting natural features/phenomena from the interacting natural processes in a chosen geographic environment.	2	Geo1.1.2.2
13	Describe the elements of the interacting natural processes that operate in the chosen geographic environment.	2	Geo1.1.2.3

14	Describe the specific characteristics of the elements of the interacting natural processes that operate in the chosen geographic environment.	2	Geo1.1.2.4
15	Describe the local spatial and/or temporal variations in these natural processes using specific case study evidence.	2	Geo1.1.2.5
16	Explain how human actions has modified a natural process in a chosen geographic environment(using case study evidence)	3	Geo1.1.3.1
17	Analyse how each process operates (which may be at different rates and scales) within the chosen geographic by describing how one process operates	3	Geo1.1.3.2
18	Explain comprehensively (using case study evidence) why there are local spatial and/or temporal variations in these natural processes	3	Geo1.1.3.3
19	Explain comprehensively how these interacting processes have affected the distribution of phenomena using specific case studies	3	Geo1.1.3.4
20	Discuss the interactions in these natural processes using specific case studies, and diagrams	4	Geo1.1.4.1
21	Evaluate the extent to which these natural processes have been modified by human action referring to specific case study evidence	4	Geo1.1.4.2

OUTCOME 1: Elements of the interacting natural processes that operate in Mele Coastal environment.

- ***Natural Processes Interacting at Mele Coastal environment:***
  - **Geomorphological processes** (weathering and beach profile)
  - **Hydrological processes** (**wave erosion** -wave pounding , Hydraulic pressure, attrition, abrasion/ corrosion, corrosion/solution, sub-aerial erosion), weathering, wave refraction, longshore drift, wave deposition, fluvial deposition, tidal processes)
  - **Climatological processes** (Aeolian processes- saltation process & storm wave action)
  - **Biogeographical processes** (Dune formation-deposition landform)
  - **Pedological processes** (Beach sorting/ Beach slope)

- ***Elements of the natural processes at Mele coastal environment***
    - Wind
    - Tides (low/high)
    - Sea level change (rise/fall)
    - Sediments (alluvium/ coral fragments, limestone fragments)
    - Beaches
    - Rock (Volcanic breccia, limestone)
    - Sand
    - River
    - Coastal Vegetation (Dune grasses/ mangroves)
    - Sea salt spray
    - bay & seafloor
    - Waves
    - Ocean fetch
    - Temperature
    - Precipitation
    - Sunshine hours

- ***Analyse the Interactions in these natural processes (elements & interaction)***

Example 1: The interactions between **wave**, **wind** and **beach sediments** result in **longshore drift process.**

Example 2: The interactions between the soft **volcanic rock** and **plunging wave** result in **wave erosion** processes caused by wave pounding, hydraulic pressure, abrasion/corassion.

Example 3: The interactions between **wind, dry sand** and **vegetation** results in **dune formation** process.

Example 4: The interactions between **plunging wave** at northern section of Mele beach, **beach steep slope**, and **high tide** may result intensive **wave erosion** on the beach.

Some explanation of elements and Interaction at Mele coastal environment

Elements	How they interact
Wind → Waves Wind → Coral fragments Waves → Coral fragments	Strong south Easterly winds and powerful plunging waves erode coral fragments from the reef behind the Hideaway Island. The wave removes coral fragments and transports them to another place according to the wind direction. SE trade winds or East South East winds cause wave front to approach the shoreline of an oblique angle.
Wind speed → Sediments Wind Direction → Wind speed Sediments → Wind Direction	River Tepwukoa deposits silt and mud at the river mouth, as velocity slows down. Wind directions causes the Longshore drift (LSD) to move the materials westwards across the river mouth forcing the river to reach the sea further west, thus forming deflected river.
Particle size → Strong waves	Strong waves erodes and drags beach sediments along the sea bed, breaking them further into smaller and smaller particles.
Waves → Wind Waves → Beach sediments Wind → Beach sediments	Longshore drift is generated as a wave approaches a shore at an angle (ie the wave is not parallel to the shore). This often occurs when the prevailing wind (the wind that blows most often) is at an angle to the coast. As the wave breaks, water and sediment are transported at an angle up the beach in the direction of the wave's advance which create the zigzag pattern.

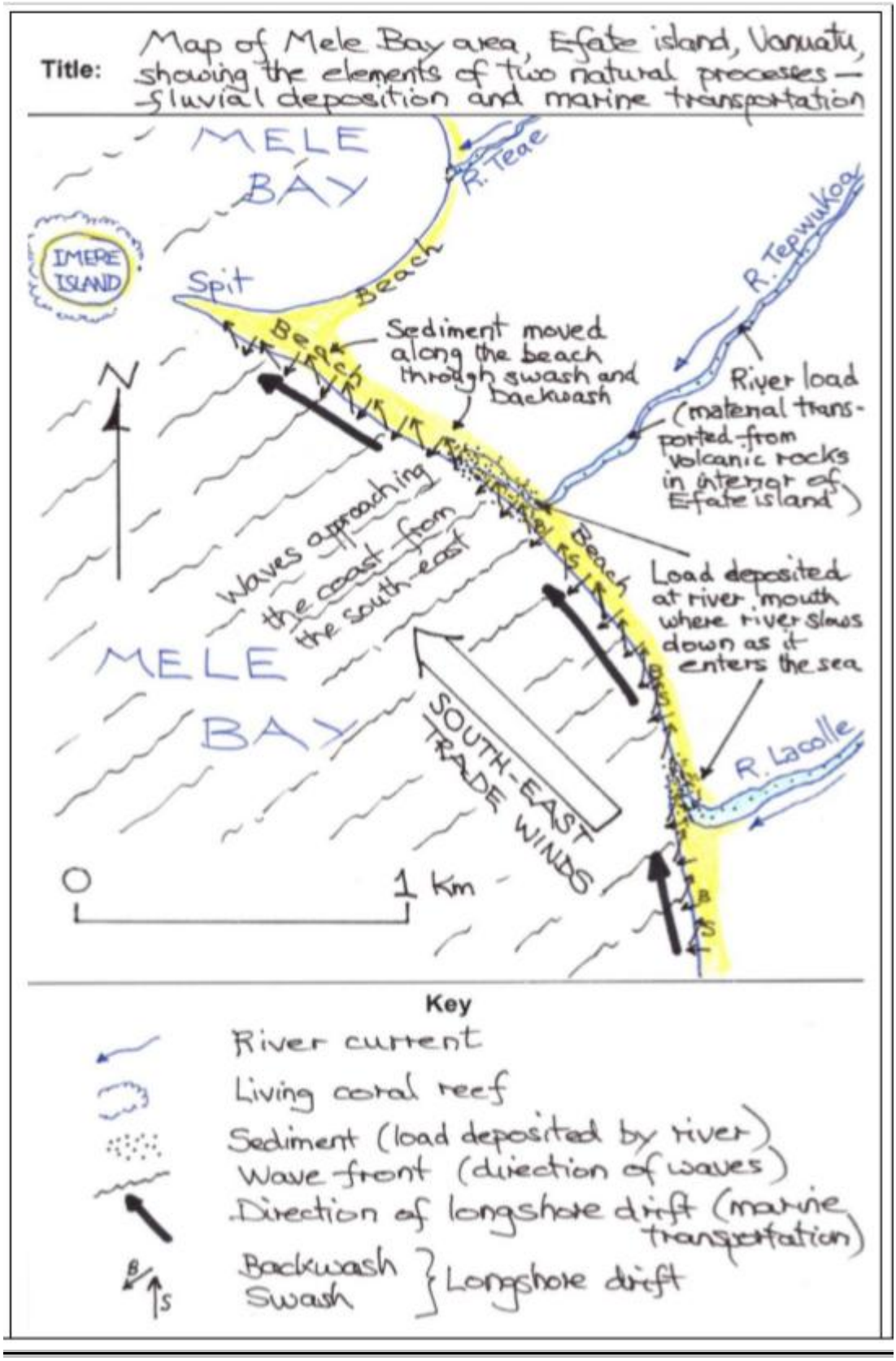
Questions

1) Name the natural processes studied?
2) Name the interacting natural processes at Mele bay geographic environment.
3) Identify the elements of the interacting natural processes of Mele bay geographic environment.

Question

- **Draw an annotated sketch map or key map of Mele coast to show at least elements of the interacting natural processes that operate in that environment. Provide a title, key and approximate scale for your map**.

Example: Elements of Fluvial deposition and Marine Transportation



OUTCOME 2: Natural Processes operating at Mele Coastal environment.

How do natural processes operate at Mele Coast?

Process	How it operates
Wave Erosion	-Waves coming from the ocean arrive with tremendous amount of energy. When the waves arrive, at the coast where there is cliffs and headlands, the energy is hauled against the headland eroding it piece by piece. Eroded material is then carried by the waves and thrown back against the headland to cause more erosion. Erosion by waves is made even more severe, when wind energy supports the wave energy causing more force to be applied to the headlands, thus causing more erosion. Areas more exposed to storm waves will experience more erosion than sheltered areas, and it happens to a greater extent during bad weather, when waves and winds are larger.
	Plunging waves forms less powerful swash due to the steep slope of the beach, however when the backwash return it has more power energy to cause erosion on the beach. Erosion is greater on alluvium deposits at Mele beach. Also when this wave come first to first with the limestone cliff at Malapoa headland erosion becomes severe. Erosion may be greater also when carbonic acid of the sea water dissolved limestone and evaporation of salts causing the rock to break apart. Erosion is greater also through hydraulic action where air is trapped and compressed either in a joint in cliff or between breaking wave and a cliff. This weakens and breaks off pieces of rocks and erosion is severe.
Wave Deposition	-Spilling waves are greater during calm condition where South East trade winds is not strong enough to create destructive waves but and -when the beach profile is of low gradient then spilling waves occurs more which allows deposition of sediments on the beach. Spilling waves forms greater swash which gives more time for infiltration of water on the beach. Backwash is less powerful as more water is lost by infiltration process. Therefore, a lot of sediments are deposited on the beach than is carried back to the sea. This process is dominant within the Mele bay.
Longshore Drift (Marine transportation)	-The Mele coast always receives a South Easterly prevailing wind and this affects the process of longshore drift along the Mele beach. The drift occurs when prevailing South East trades are oblique to the shore. It is greater when the prevailing wind is at an angle to the coast. As the wave breaks, water and sediment are transported **at an angle up the beach** in the direction of the wave's advance.

	-It becomes greater when wind is strong, high tide and during hurricane when violent winds are oblique to the shore. Heavy rains inland cause rivers to have greater discharge and more deposition of sediments at the mouth of River Tepwukoa. Due to the drift the sediments are moved westward which causes the river to **deflect** at its mouth.
Fluvial deposition (River)	-Sediments come from the volcanic rock in Efate mainland. Heavy rain causes the river Tepwukoa and others to carry these volcanic debris down to the Mele coast where the sediments are deposited at the river mouth where water velocity drops. Wave carries those sediments and deposits them in other parts of the coasts.
Geological Processes-: (**volcanism**, **Tectonic uplift**, **sedimentation**)	- The rock structure of Malapoa headland is a material form from a large volcanic activity 17-20 million years ago. - Due to climatic forces materials are weathered and eroded. These materials are carried down to and deposited on the sea floor where finer materials become soft sedimentary rock known as the Volcanic breccia. -some million years ago, land was uplifted, pushing up large flat coastal terraces that made up the flat tops of the present coastal cliffs of Malapoa plateau.
Wave refraction	- As wave crest approach the shallow water near Malapoa headland or Hideaway island, drags from the sea flow slows the wave. In deep water of bays, the wave keeps constant speed. This means that a wave bends (refracts) around the island and headland, concentrating erosive energy occurs. Whereas energy is dispersed in open Mele bay. The waves entering the Mele bay from the Easterly and South Easterly direction refract around the Hide away island.
Tidal Processes (current)	- The tide is caused by the pull of the moon dragging water to that side of the Earth nearest the moon. -High tide during a large storm will create large waves. These waves as they arrive at the beach will create powerful backwash that results in a lot of erosion of sediments and sand to the offshore. Tidal process interact with wave actions may change the coast environment.
Dune erosion	This is greater during high tide and stormy weather when swash may reach high level of the beach causing erosion to the dune. Wind action may cause erosion to the dune if the coastal vegetation is removed.
Dune formation	-Dune forms is form in wide coastal areas where there is enough land for sand to accumulate. -Strong prevailing winds may transport dry sand from the beach face and berm to landward area of the back shore. -sand grain must be small enough to be moved by wind and it occurs most in low gradient beach with large tidal range.
Weathering	-Limestone rocks are broken by weathering processes. This involves water which is one of the most important elements. This may involve rainwater or sea water which enters the joints or cracks in the rocks and

	breaks the rock down. -The sea water enters the rocks and over time, water evaporated leaving the salt crystal to grow within the rocks and finally may cause the rock to break. - The limestone rocks at Malapoa headland and reefs are affected by the physical or chemical weathering processes.
Wave energy processes	-Processes of wave energy operate mainly through the action of waves in deep water transferring energy to waves in shallow water, then through the breaking waves. -The plunging breakers are most frequently when slow waves approach a steep beach. The swash or upbeach movement is not as strong as the down beach movement, the backwash. -The other end of the series is the spilling breaker, in which most of the breaking water is directed upbeach. The swash is much strong that move sediments upbeach. The returning backwash is weak therefore the sediments are deposited upbeach. The spilling breakers occurs mostly where the beach is gently slope. -This spilling wave occurs at the middle section of the Mele Coast but the plunging breaker is mostly towards the northern section of the Mele coast.
Saltation processes	The land and sea breeze are capable of moving a considerable amount of material. Dried sand often engaged in a leaping motion especially during the dried sunny day. The grains strike the ground with force and rebound in the air. At the same time the surface layer of sand grains creeps downwind as the result of constant impact of the bouncing grain.
Beach slope	The size of the beach material has an effect on the slope of the beach in the swash zone or beach face. **The larger the size of the sediment, the steeper the slope. Slope angel can be related to particle size**. Parts of Mele coast tend to have lower beach slope angle while the other part has steeper beach slope angle.
Beach sorting	The sand at Mele beach are well sorted with some parts of the beach large size particles are found dominant while in some parts small size particles are present. This is due to the different effects of swash and back washes. If the waves are of spilling type, the coarser material is moved up the beach by strong swash. If the backwash is weaker, the coarser particles remain there. The coarsest(large) particles are then to be found at the limit of wave action, where the finest ones are moved into the lower energy zone offshore.

- **Process – Response Model**

Use the **Process- Response Model** to illustrate **how the process operate**.

PROCESS-RESPONSE MODEL IN A COASTAL ENVIRONMENT

Elements	**Interaction**	**Features**
Water		cliff
Rock		beach dunes
Wind		shore platform
Soil		
plants		
INPUTS	**TRANSFORMATION**	**OUTPUTS**

Question:

Explain how one natural process in your Pacific geographic environment operates (the sequence of events that happened; rate and scale in which the natural processes works). Support your explanation with specific case study evidence.

Example: **Wave Erosion**

-Waves coming from the ocean arrive with tremendous amount of energy. When the waves arrive, at the Mele coast where there are cliffs and headlands such as Malapoa point, the energy is hauled against the headland eroding it piece by piece. Eroded material is then carried by the waves and thrown back against the headland to cause more erosion.

Erosion by waves is made even more severe, when wind energy supports the wave energy causing more force to be applied to the headlands, thus causing more erosion.

Areas more exposed to storm waves will experience more erosion than sheltered areas, and it happens to a greater extent during bad weather, when waves and winds are larger.

OUTCOME 3: Process Interaction

How do the Processes illustrate interaction among natural phenomena in Mele coastal environment?

Process	Interaction	Process
Geomorphological- Cliff form	The form of a cliff will depend on its structure. Abrasion will cut a notch in the cliff face. The presence of a notch indicates absence of joints in the rock of a cliff plus continued exposure to wave action. At Malapoa headland the cliffs are form as a result of the interaction between these two processes.	**Hydrological**- Wave Erosion
Geomorphological- Sea floor topography	The angle at which waves strike the coast varies considerably. The frictional drag of the sea floor causes waves to swing round the Imere island until they are almost parallel to the shoreline. Wave refraction in the shallow water behind the Imere Island creates concentrated wave energy which causes a lot of erosion to the Imere Island. Wave energy become less which may only deposit material within the Mele bay.	**Hydrological-** Wave refraction Wave deposition wave erosion
Hydrological- Wave energy Processes	The essential parts of Mele beach are determined by the interaction between the wave energy and the nature of the materials. The wave energy determined how the materials (e.g Pebble) are sorted on the beach. Much bigger materials are found within the upper section of the beach while the smaller ones deposited at the lower section of the beach.	**Pedological**- Nature of materials
Hydrological- Swash and backwash	The fragments torn from the Malapoa limestone cliffs or from the Imere reef are broken down by attrition and abrasion and are transported along the coast where they are deposited at the Mele beach. As the waves break on the Mele beach, the swash often pushes material up the beach at an angle. The backwash however moves directly down the beach slope. This zig zag movement of movement is called the longshore drift and its direction depends on that of the wind.	**Pedological** - Coral reef fragments /Limestone fragment
Hydrological- Long shore drift	-River load materials transported from volcanic rocks in interior of Efate island. As the river transported the materials down to the river mouth, when it comes to where the velocity reduces; where the river enters the sea, the materials are deposited at the river mouth. -The Sediments are picked up and moved along the beach by the energy of wave and	**Pedological-** Fluvial deposition

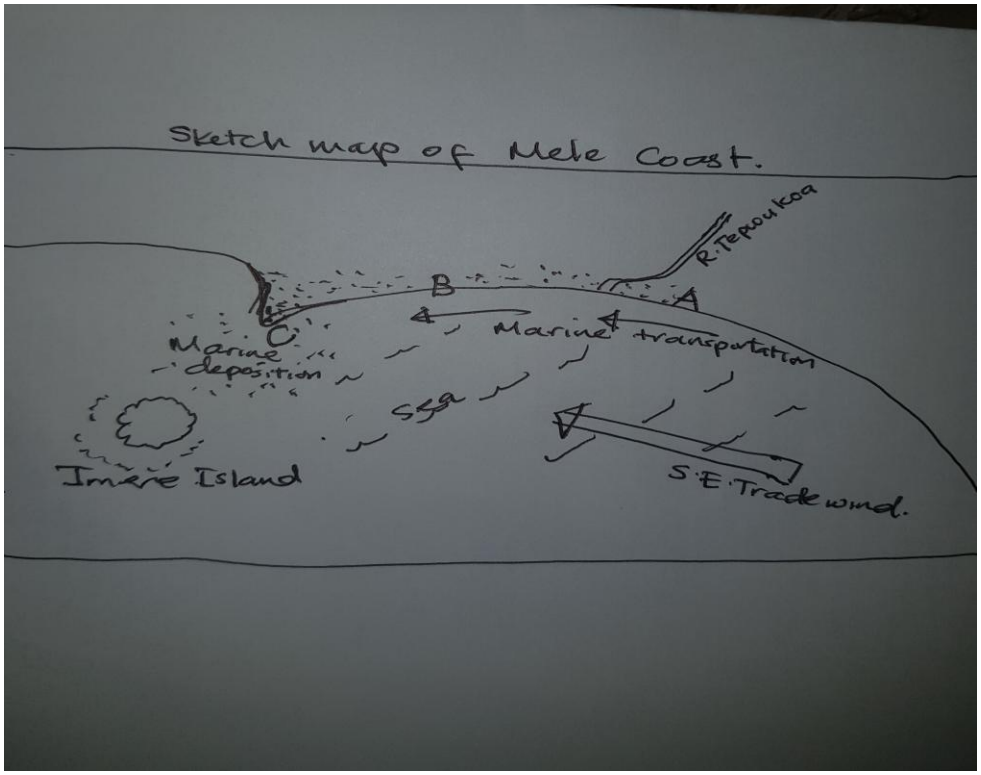
	the wind. The sediments are transported at an angle up the beach in the direction of the wave's advance as swash and when the wave energy is spent, water and sediment return with the backwash directly down the beach perpendicular to the shore forming process of longshore drift.	
Hydrological Processes Longshore drift	A spit is a bank of sand/ or shingle, projecting from the shoreline into the sea or partially across the mount of a river estuary or deep coastal inlet. The far point of a spit is commonly recurved, either by refraction of waves or the approach of local waves from a direction along to that of prevalent beach drift. At Mele coast, the LSD carries the sediments westward direction and deposited them where it forms the sand spit west ward direction of Suango point.	**Beach materials**
Climatological- Aeolian action	The west ward movement of drift along the Mele beach away from the River Tepwukoa is influenced by the South East wind direction that daily approaches the Mele beach between the months of November to April.	**Hydrological**- Longshore drift
Climatological- Aeolian action	Sand dunes are often found on spits and elsewhere. They are produced by wind carrying sand along the beach and depositing it in heaps around obstacles such as pieces of driftwood or coastal vegetation. These dunes grow as more sand is deposited by wind. Coastal plants such as marram grass or other drought-resistant plants can trap this sand with their roots from moving further inland. At the Mele coast, dunes are form at the backshore where it causes the beach becomes steeper in some parts of Mele coast.	**Pedological-** beach materials
Geomorphological- Weathering	Tectonic uplift produced raised reef which form the Malapoa cliff, weathering occurs to the limestone which break/crack them into boulder which leaves them lose to be picked up during storms waves and high tides. Wave picks up the broken rocks and thrown them back at the cliff base as abrasion which causes further break down of rocks into smaller pieces where it becomes lighter that wave energy can carry them to the other part of the coast. The sediments are carry and deposited north section of the coast where the Suango point is.	**Hydrological-** Marine erosion

Climatological- Rainfall	The regular rainfall at the Mele coastal plain helps the growth of the coastal vegetation to reduce the coastal erosion. However removal of the coastal vegetation for construction, sports and settlements do greatly increase the erosion of sand along the coast.	**Biogeographical**- Coastal vegetation
Marine Erosion **Marine Deposition**	During strong winds, waves erode and remove sand and transports them (LSD) westward towards Imere Island and deposit them at the Suango point which forms the sand Spit.	**Longshore Drift**

<u>Example 1</u>: Wave erosion ⟷ longshore drift (LSD)

Interaction refers to the effect of two or more variables. At Mele coast, there are a lot of variables interacting to keep the coastal processes active. As seen in the sketch diagram below, at Point A, erosion of coastal sediments in which greater due to plunging waves and human activities (sand minning) found there. With the help of the wind that causes the waves to be large in fetch, it erode the sediment from **point A**. Together with wind direction south east direction, it then transport them along the shore known as **LSD**. The sediments transported are then deposited at **Point C** where there is constructive wave (spilling) that carry the eroded materials back to the shore.

<u>Annotated sketch diagram showing the interacting natural processes at Mele coast, Efate Vanuatu</u>.



However, during the storm, the water level increase and waves become larger that they can reach the upper section of the beach. When this happen the swash can be less while the

back wash is greater therefore the deposited sediments at **Point C** can be washed down to the offshore where it forms a **full offshore bar**.

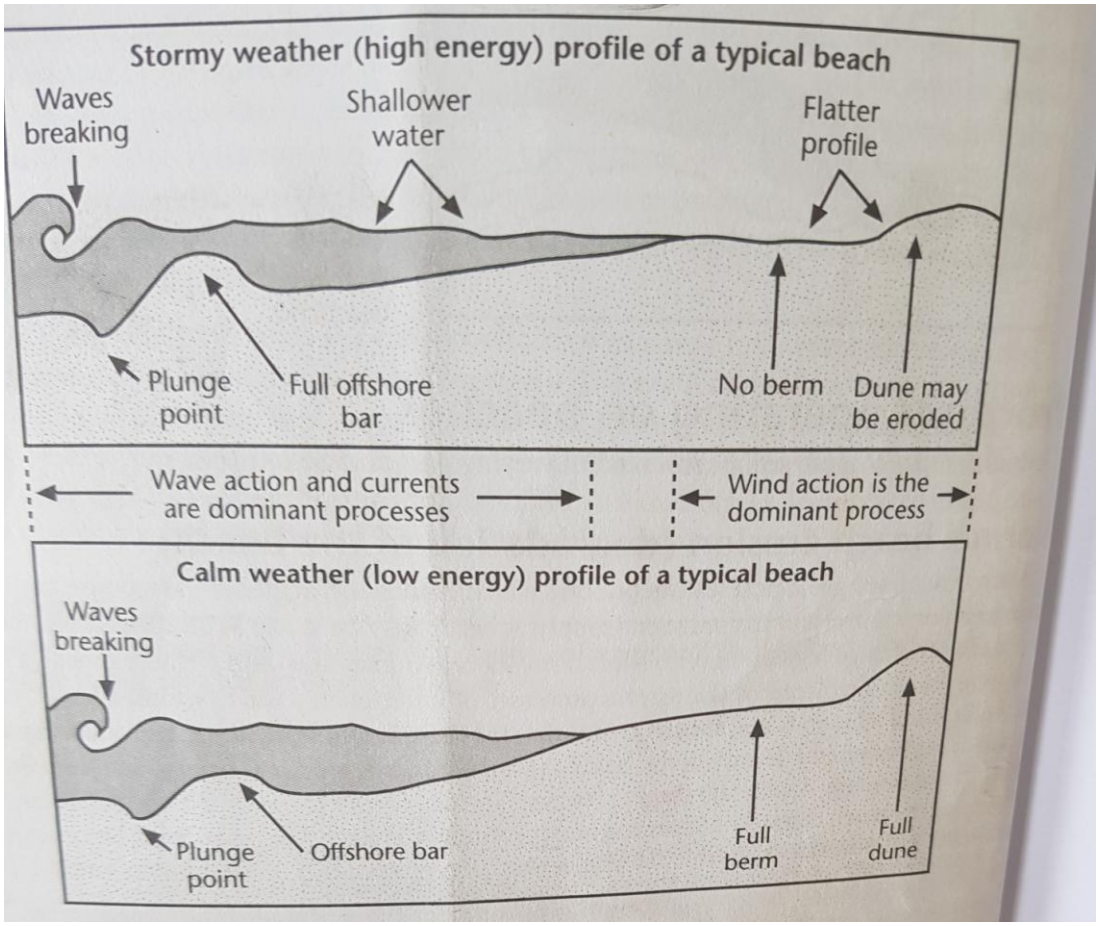
OUTCOME 4: Local spatial and/or temporal variations in the natural processes.

Why are local spatial and/or temporal variations found in natural processes at Mele coasts?

The main spatial variation in the coastal environment is between areas of erosion and areas of deposition (aggradations). A coast of erosion is an area of highland or hills at the coast which form cliffs when eroded; where an area of deposition is an area of lowland near the coast- flat plain.

There are temporal variations in the beach environment itself. Beaches vary, depending on the climatic acting at any one point in time. A beach takes on characteristic profiles depending on whether the condition is stormy or calm. During the **stormy weather** the **beach profile will be flat** meaning;

- dune may be eroded
- berm will disappear
- there will be a full offshore bar.



During **calm weather, beach profile is of full beach** (ie the beach contains a high volume of sand. Berm and dunes are full.

Spatial Variation- differences from one place to another in the operation of a process that can be seen or measured, or differences in geographic phenomena/ features from place to place.

Temporal Variation – is how things change over a period of time. Examples of temporal variations include: even, uneven, fluctuating, e.g. stronger, going in different direction, more magnitude, different speeds or rates, different geology, different slope, different pattern.

i. Variation of a natural process over time at Mele Coast.

Examples:

- **Longshore Drift** – Occurs within short-term which daily. It is greater when wind is strong and even greater during high-tide. Seasonally it occurs a lot during the month of March and November.
  It is greater during hurricanes when violent wind is oblique to the shore. Heavy rainfall inland which causes River Tepwukoa to have greater discharge with more deposition on the river mouth.

- **Marine Erosion** - Marine erosion occurs daily but is greater when winds are strong with high tide. Seasonally erosion occurs a lot at Mele coast during the month of April to November, which also a cyclone season.

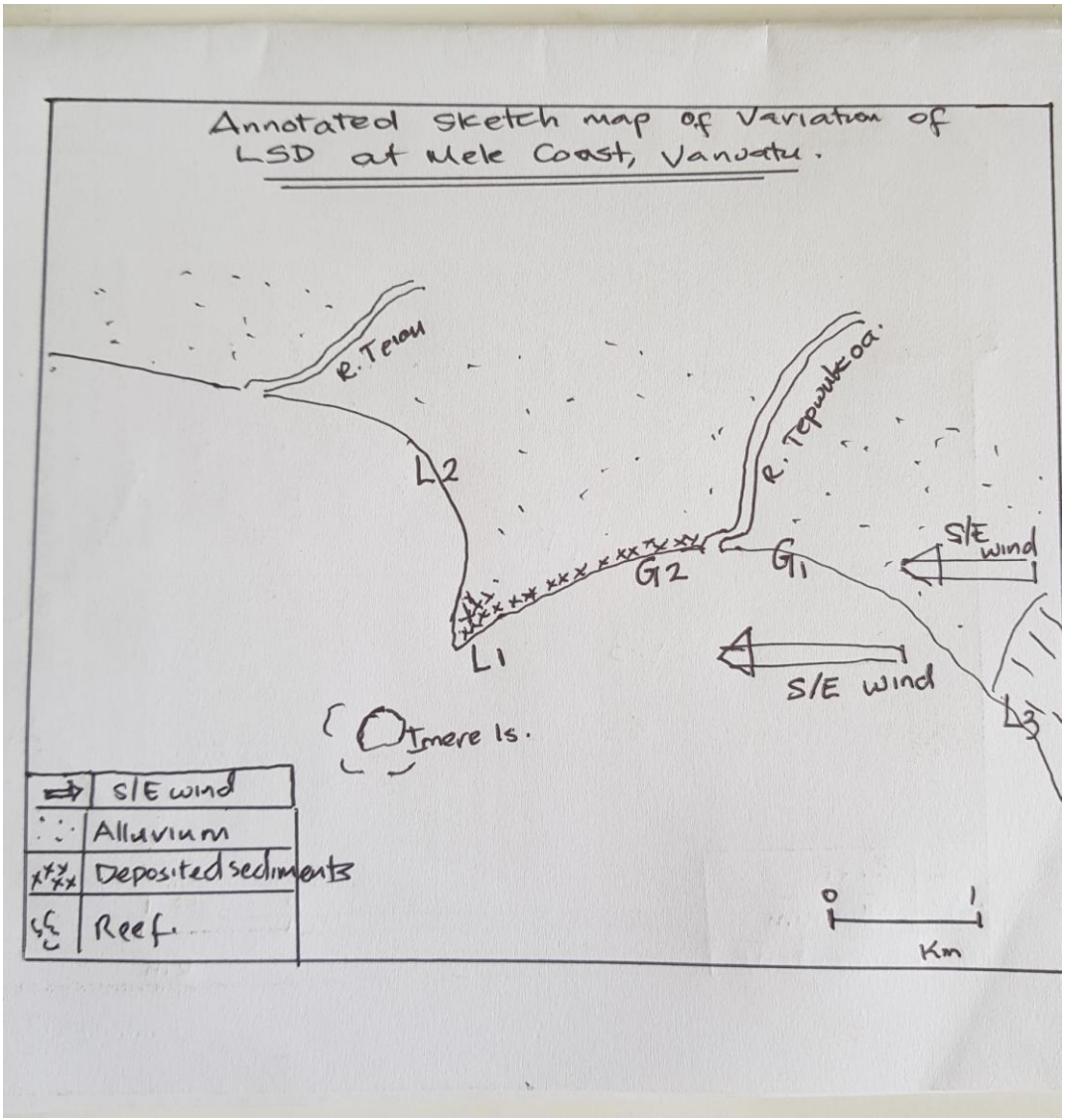
- **Fluvial deposition**- River Tepwukoa transported materials down from the volcanic interior of Efate Island and this becomes more severe during long period of heavy rainfall. This load was deposited at river mouth where the river slows down as it enters the sea.

- **Marine Deposition**- Mele beach often experience certain time where the coast has experienced a 'full beach' which means there is a high volume of sand on the beach. This often occurs during a low energy or calm weather conditions. This is created by sand being pushed up onto the beach by low-swell waves. These are the constructive waves which create powerful swash that carried sand onto the beach and deposit there. Swash is lost by infiltration into the beach sand and backwash is reduced.

ii. Variation of a natural process over space at Mele Coast.

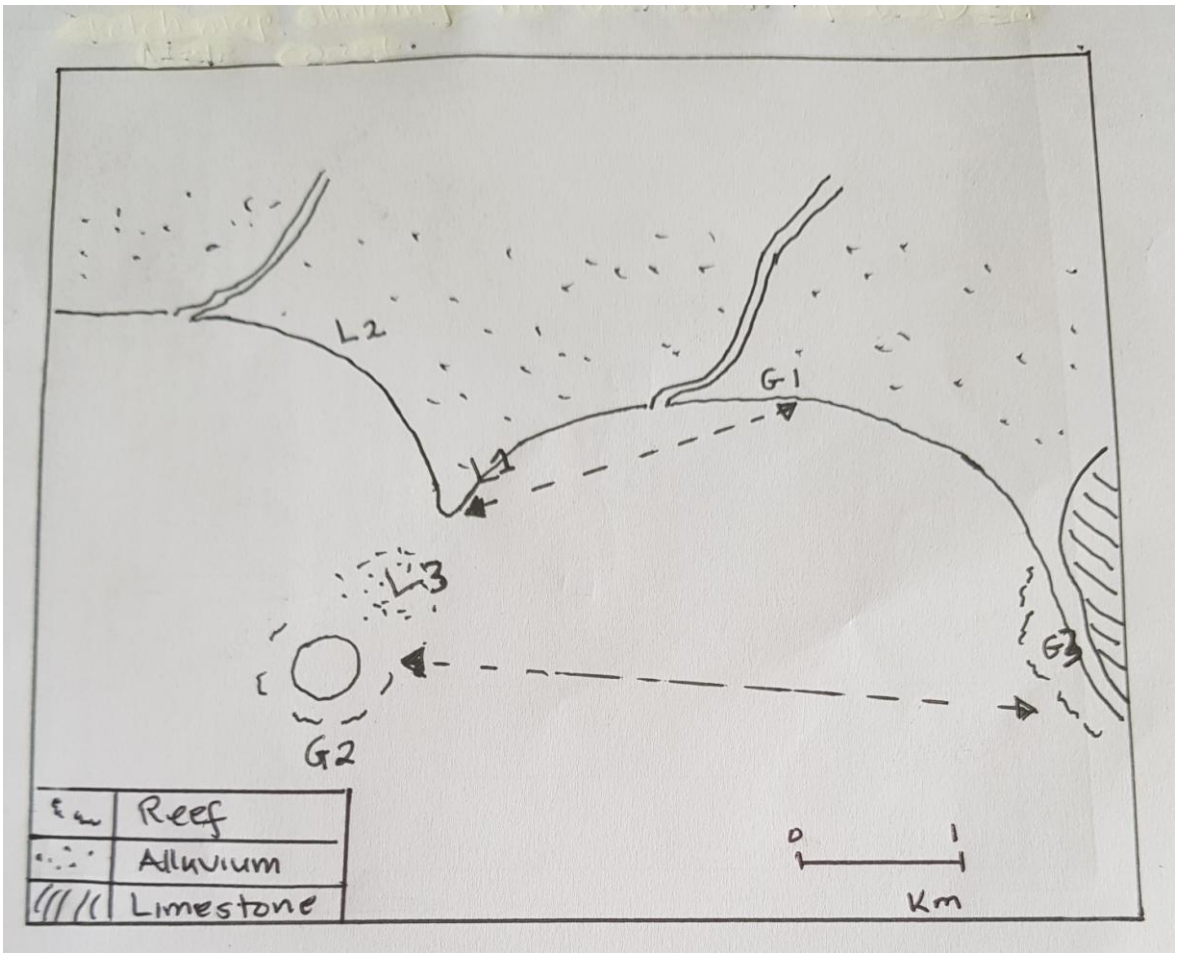
- **Longshore drift** – At Mele coast wind is always from the South East/or East South East direction all throughout the year. When wind is from the South East or East South East direction, the drift is greater at point marked **G1-G2** and less at point marked **L1-L3**. This is because at **Gs** the south east trade wind is parallel to the shore pushing materials westwards.

Example # 1: Map key or annotated sketch map showing the variation of Longshore Drift Process at Mele Coast, Efate, Vanuatu.



- **<u>Marine Erosion</u>** – Erosion is greater at points marked **G1-G3** and less at points marked **L**. This is because in **G1**, the South East trade wind is oblique to the shore and the openness of the coast, creating strong longshore drift to occur which causes erosion of materials along the beach. At **G2**, strong refracted waves behind Imere Island may erode dead corals and transport them to the **L3**. At **G3**, broken coral fragments and limestone fragments are eroded from Malapoa reef and Malapoa cliff by the wave action. At **L1**, due to the effect of Wave refraction which wave is perpendicular to shore and slowed down by the headland and the Imere Island, less erosion occurs. At **L2**, the prevailing winds are reaches offshore, therefore no strong waves to cause erosion.

<u>Example #2:</u> Map key or annotated sketch map showing the variation of Marine Erosion at Mele Coast, Efate, Vanuatu.



OUTCOME 5: Distribution of features.

How have natural processes affected the distribution of natural phenomena at Mele coast.

Feature	Processes	Example(s) of interaction
Sand spit	Marine transportation Marine deposition Fluvial deposition Aeolian action	River Tepwukoa deposits silt and mud at its mouth. Longshore drift then transports this material westerly direction according to the SE prevailing wind. The swash and backwash move sediments along Mele coast beach. More beach materials depositing, it causes the beach to grows outward from the main land where it forms a spit.
Deflected River	Fluvial deposition Marine transportation Marine deposition	River Tepwukoa deposits silt at its mouth as velocity slows. LSD then drags this material across the river mouth forcing the river to reach the sea further west.
Beach	Marine erosion Marine deposition Marine transportation Fluvial deposition	More erosion caused by plunging waves that removes beach materials (sediments) from the beach and deposits them off shore. When wind dies out, low- swell waves occur and carries materials back from offshore and deposits them on the beach. Mele beach often experience certain time where the coast has experienced a 'full beach' which means there is a high volume of sand on the beach. This often occurs during a low energy or calm weather conditions.
Coral Island (Imere Island)	Marine erosion Marine deposition Marine transportation	Waves remove coral fragment during hurricane and transport them according to dominant wind direction. Where currents meet due to refraction and deffraction, sediments are deposited. For example; East of Imere Islands.
Cliff (At Malapoa)	Tectonic uplift Chemical weathering Marine Erosion	Tectonic uplift produced the Kawenu coastal plateau that forms the present coastal headland. Weathering occurs to the limestone that breaks the rocks into fragments which is ready to be picked up in storms and thrown back at the cliff by waves or eroded by the waves. This leaves the steep sea ward

		face of the Malapoa headland. It is call a cliff.
Stack	Marine erosion Reef building Marine transportation	Coral fragments are picked up in storm and thrown back at the cliffs by waves (marine erosion) Reef-building produces coral polyps near the Malapoa point and north behind the Imere island. Coral are broken by strong currents in storms and people stepping on them. At Malapoa reef the strong wave current transport those rocks and corals towards the cliff which causes abrasion against the limestone rock to cause further erosion on the soft limestone rock. This further erosion creates a cave and further produces the stack.
Black Sand beach	Volcanic activity Fluvial transportation Marine transportation Marine deposition	The black volcanic rocks in the interior of Efate island has gone through weather process then later is transported to Mele coast by the river. The materials are then deposited at the river mouth where the river slows down as it enters the sea. This black volcanic sand moved along the coast through swash and backwash according to the wind direction. This materials dominate the beach.

<u>Example 1</u>: Coastal erosion ⟷ Coastal Deposition

↓

Coastal transportation

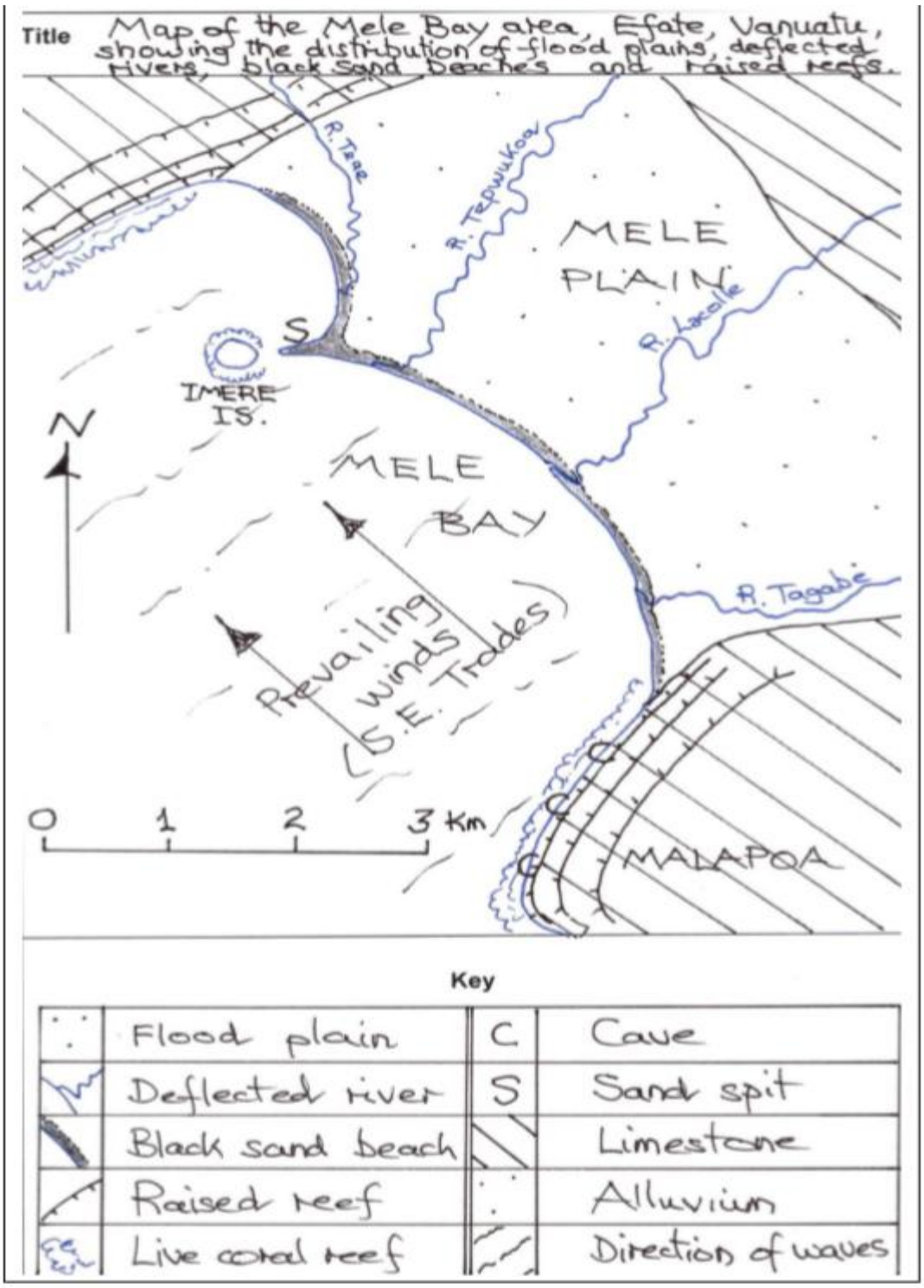
These three natural processes interact due to the interaction of the different elements operating at Mele coast. During storm weather/ or high tides plunging waves (destructive waves) move towards the shore where greater backwash is created and swash is less. With the help of human activities (sand mining), backwash carry the sediment back to the sea which known as **coastal erosion**. **Waves transported** these eroded materials with the help of the south east prevailing wind begin to transport the sediments West/or North-west direction of the coast towards where it approach the area where the constructive wave (spilling) are more dominant. The wave energy become less powerful to continue

transporting the sediment thus; accumulate the sediment together which is known as **coastal deposition**. This formed coastal features known as the **sand spit**.

Question.

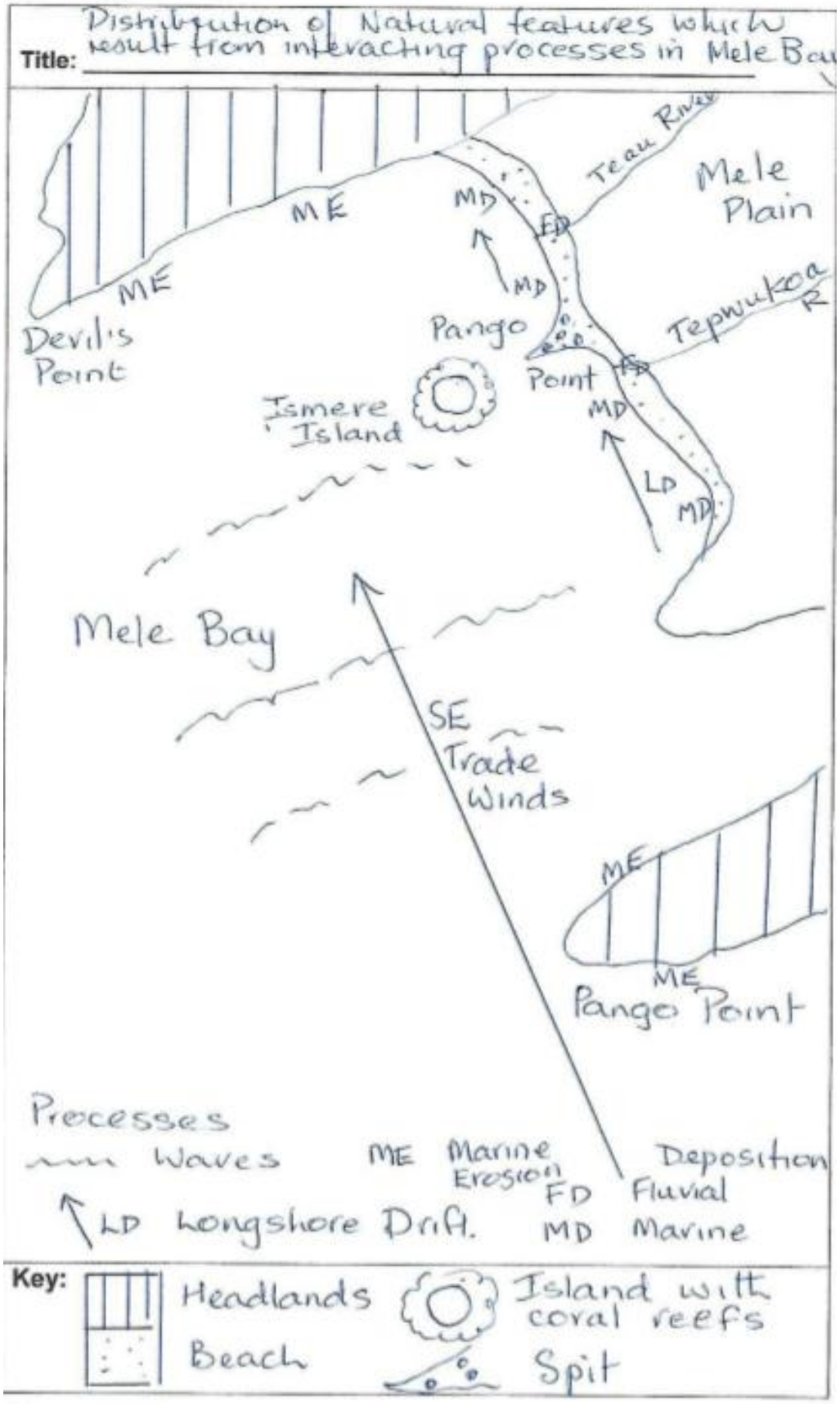
Draw an annotated sketch map or key map to show the distribution of **FOUR** different natural features / phenomena that result from the interacting natural processes in your chosen geographic environment. Such **natural features** might **include beach, coral reefs, cliffs, stacks, caves, flood plains, deflected river, blank sandy beach, sand spit, alluvium, wind direction, lsland with coral reef, limestone, etc. Add a title, key and approximate scale.**

Example 1:



Example 2:

Draw an annotated diagram/map to show the **distribution of natural features/phenomena** which result from the interacting natural processes in your chosen Pacific geographic environment.



OUTCOME 6: How humans have modified the natural processes at Mele Coast

- **Explain how human actions have modified or could modify ONE natural process operating in your chosen geographic environment.**
- **Evaluate the extent to which these natural processes have been modified by human actions.**

Human activities	Modification	Effect / extent
Gathering of shellfish and tourists walking on reefs	Walking breaks coral polyps. More fragments available for transportation when storms occur. Powerful waves pick up coral pieces and erode the shoreline.	This may cause marine erosion to increase is such shoreline and marine transportation will occur.
Construction of boat ramps (Imere Island).	Groynes and ramps slow down LSD and so sand is piled up at the bottom of the groynes. Groynes may cause the wave to return its direction between the groynes and the wave front.	Marine transportation slowed down by the disturbance of the groynes but marine erosion is increased. Groynes causes reflection of wave energy and wave move outward pulling sand.
Construction of groynes	Waves in shallow water may be affected by building of groynes which may protect loss of sediment from the beach at Imere Island.	One end of the beach is protected which reduces the erosion of sand yet the other is experiencing more removal of sediments.
Use of beaches for picnicing and horse riding	Vegetation removed to clear the coasts for picnicing. No vegetation roots to stop sand being blown away by wind or washed away by wave.	SE prevailing wind increase the saltation processes which erodes the sand up the back of the beach and marine erosion increased also during high storm waves that increases the erosion of sand down offshore.
Minning of sand on beach at Blacksand or Mele beach	Destabilization of sand on the beach which loosened easily carried by waves or wind. Holes that were dug are being replaced by sediments from somewhere.	Marine transportation and marine erosion is increased
Reclaiming land at Imere island for artificial beaches & Building up of Imere Island	More sands and other materials on the beach. Artificial mounds easily worn away by strong wind and high storm waves.	Marine transportation as those reclaimed sand may not strong against erosive power of waves. Marine erosion increase. Marine transportation and erosion increased by the SE prevailing wind and storm.
Creation of Golf Court at Mele	Removal of vegetation for the court therefore less vegetation to hold sand together and so they are easily removed by wind	Wind erosion, wind transportation and wind deposition increased. Marine erosion increased.

	and wave.	
Quarrying for sand along R. Tepwukoa	Materials are loosened and easily carried by river or waves entering river mouth.	Fluvial erosion and fluvial transportation at river mouth increased.
Dredging	-may interfere with sediment transport and flow dynamics in coastal and marine systems.	-slows down the sediment transportation and allow sediments to accumulate at the bottom of the obstacle.
Land reclamation	– removal of coastal vegetation makes the coast vulnerable to coastal erosion/inundation, cause salinisation	-increase vulnerability of sediments along the coast. Erosion of sediments can be greater by storm waves.
Beach scraping	-is the process of reshaping beach and dune landforms with heavy machinery can create dunes, which are used to give property owners some security from beach erosion, severe storms, and winter wash over events. During the summers, the created sandbanks may be bulldozed flat, providing water views to property owners..	However, the effects of beach scraping on coastal environments are little known, and this procedure may be harmful to coastal biota and habitats.

How natural process has been positively modified by human actions?

Example: Beach Erosion

Sand erosion of Mele beach is minimized by the vegetation growing along the sand that trap sand particles with their roots, and keep them from moving. Since people have been banned from removing coastal vegetation, this has helped in reducing sand erosion at the beach. The large amount of vegetation along the coastline reduces erosion by trapping particles in their roots.

Evaluate the extent to which this natural process has been negatively modified by human action.

Example: Building of bars

The building of bars and handicraft market along the sand really disturbs the sand particles. These things attract people to go and have a look, and by doing so, you are disturbing the sand particles, and making them loose. Once loose, they are easily blown away or washed away by the sea. This increases the amount of sand erosion at the beach. To avoid or minimize sand erosion, these services can be provided, but moved further up beach, and vegetation should be planted around these areas, so the sand particles remain can be kept trapped to their roots to reduce erosion of sand.

Summary of the Marine Transportation Process at Mele Coast.

1) Between March & November prevailing winds are from the SE or ESE at speeds up to 100km per hour.
2) The constant SE /ESE wind causes the wave front to approach the sandy shoreline at an oblique angle.
3) Beach sediment is moved onshore by swash at an oblique angle.
4) Backwash is perpendicular to the shore; each particle moves back out to the sea further westward.
5) This means that beach sediments is being slowly transported westwards.
6) Beach particle (sand) are moved by marine transportation across the mouth of the R. Tepwukoa.
7) The mouth of the River Tepwukoa therefore becomes a **DEFLECTED RIVER MOUTH**.
8) Sediment is deposited by the Tepwukoa at its mouth by marine deposition as its discharge is stopped by the sea.
9) This fine sediment is moved further westwards, together with sand from east of the river.
10) A **sandpit** is formed here because waves are refracted and are now perpendicular to the shore. They also become spilling waves. Marine transportation stops and fine sand is deposited.
11) In the past, during the hurricane season (Nov-March) winds may come from a SW/W direction at speed of > 100 km p.hr.(e.g. cyclone Uma in 1987)
12) Such a strong winds cause very powerful plunging waves that can erode coral fragments from the reefs and white sand beaches around Imere island and from Imere Island itself (built of coral fragments)
13) Marine transportation carries these coral fragments and drops them on the **coral bank**, formed where waves that have been refracted around Imere Island meet together.
14) The wave energy become less, therefore it deposits these fragments forms a tombolo.

Annotated sketch map showing Marine transportation along Mele Coast.