Soil Sedimentation Effect on the Coastal Marine Environment

Tefisi Village, Vava'u

by

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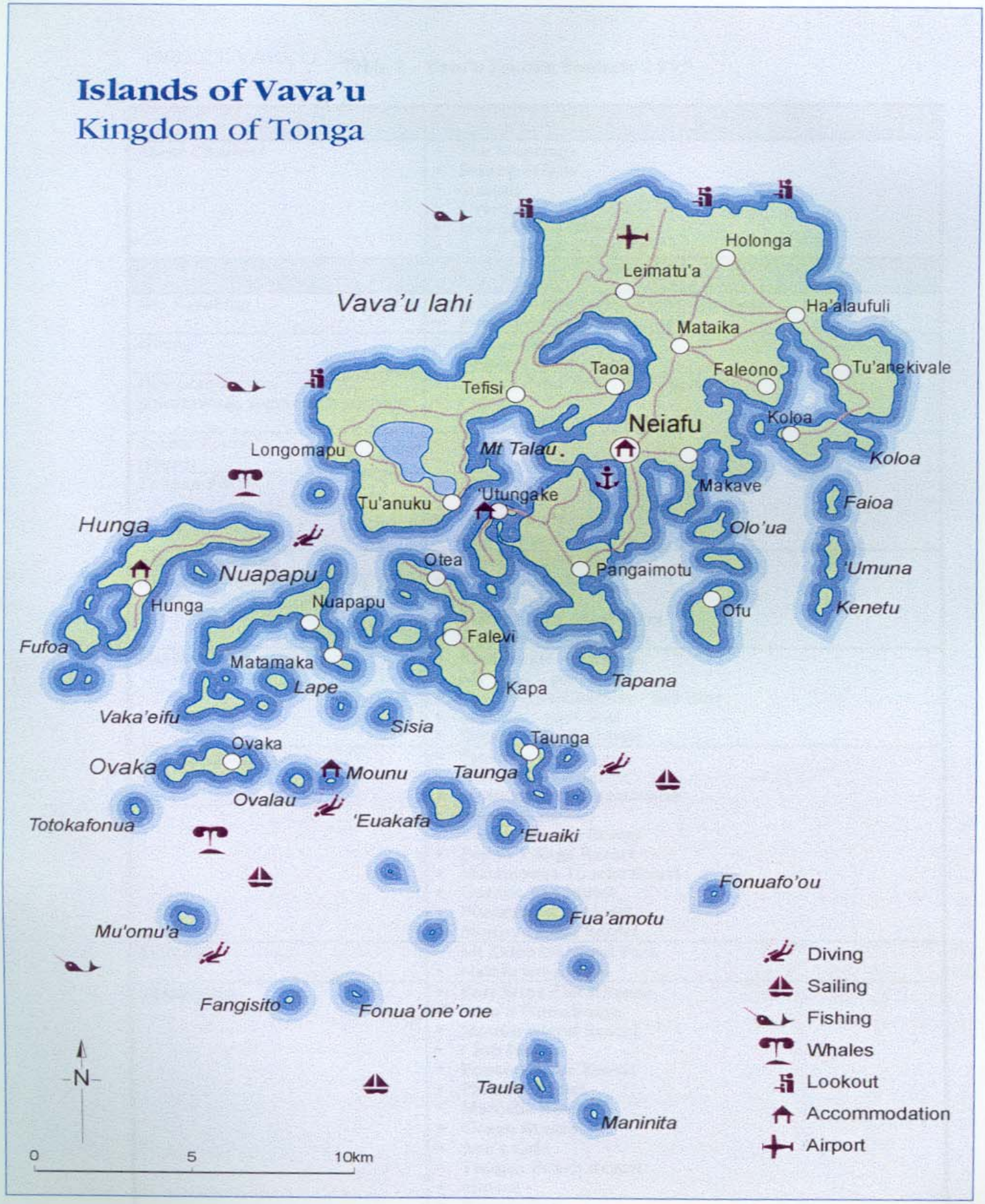
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Holonga
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Tu'anekivale
Tefisi
Neiafu
Koloa
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Faioa
Hunga
Olo'ua
Otea
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Kenetu
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Matamaka
Lape
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Sisia
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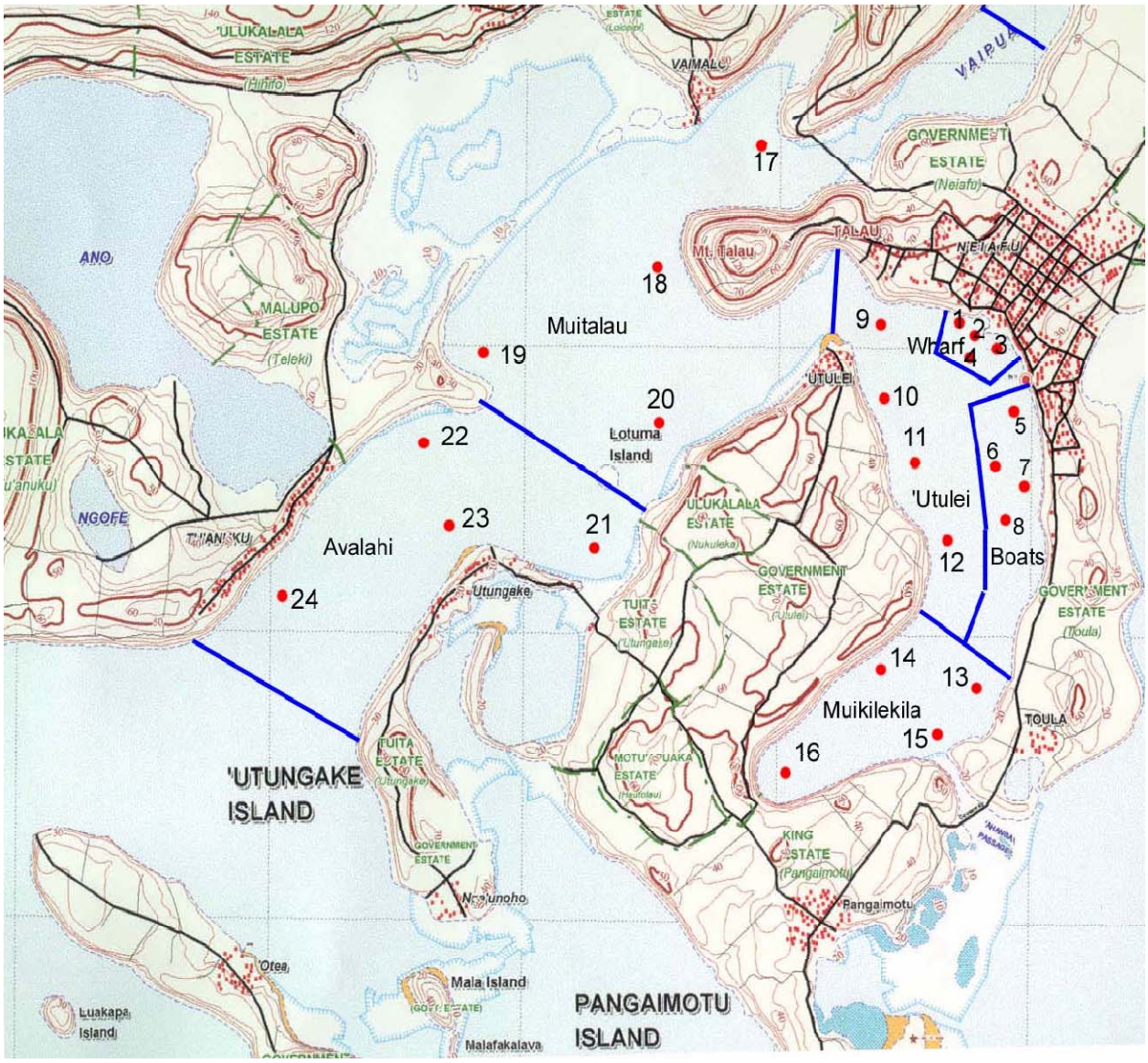


Figure 1: Shows the location of Tefisi Village and the coastal and study areas

1.0 Introduction

The Tefisi community was concerned of the possible adverse effect of soil being eroded into their coastal environment affecting the marine lives in the areas. In Tefisi, the surface soil is washed away from land development sites, farmland and the settlement areas in every significant rainfall. The fine soil particles flow into the coastal marine environment unchecked, causing the otherwise clear marine environment to become turbid. The outflow of soil not only destroys the ecosystems of the coastal environment, but seriously impacts the local fishery.

The coastline of the Tefisi Village is surrounded by lagoon with fringing reefs on the edge, forming an abundant, diverse ecosystem. Corals offer hiding places for small marine organisms such as fish, gastropods, mollusks, crustaceans, and other marine invertebrates. Some of the corals inhibitors are food for higher trophic levels carnivorous. Coral on the other hand, is also known as an animal which feed on sunlight as it depends on the photosynthesis of the symbiotic algae (zooxanthallae) for its nutrition. Thus, the deterioration in turbid water adversely affects the growth of corals. Soil accumulation on seabed reduces other marine benthos, making it impossible for them to survive.

In the coastal environment with high turbidity and soil pollution, the species richness and abundance decrease drastically. Damage to local fishery incurred by soil sedimentation is also a serious problem.

1.1 Characteristics of the Tefisi Village – Vulnerable to Erosion

Physical

- Tropical island
- High Rainfall
- High temperature
- Topography - Steep slope

Environment

- Deforestation – removing of forest for agricultural development
- Uncovered land – cleared of forest for roads, settlement, and wharf
- Destruction of coastal trees – coastal forest been cleared for social purposes
- Pigs – pigs and domestic animals are not kept in fence so they ploughed the areas easy for erosion.
- Unfenced home to hold the topsoil erosion

- Uncontrolled human activities on land

The overall aim of this study is to find out whether soil pollution and runoff really affect the coastal marine resources in Tefisi Village.

Soil sedimentation – Tefisi coastal environment

2.0 Methodologies and Indicators used

2.1 Line and Point Intercept Transect

Two sites were selected around the areas of Tefisi coastal waters. At each site on the reef, 5 (transects) replicate 20 meters length were placed haphazardly at 4 meters water depth. At each transect line, divers moved slowly along the transect line recording onto the data sheet the life forms encountered under the tape. The tape was marked at each 0.5 meter, and any life forms touched the 0.5 meter point were recorded on an underwater recording paper using pencil.

Two transect lines were also placed in vertical position running from shore to the edge of the reef. The idea of using this method is to draw up a profile of marine organisms inhabiting the area from shore to reef areas, and to identify any zonation and habitat partitioning in the study areas. It is also important to take note the abundance of marine organisms in the study areas. Application of same procedure as applied above.

2.2 Line belt transect

Line belt transect was used for indicator species (butterfly fish) counting. Placing the same transect line (tape) on the reef, after benthos counting (above), wait for 10 minutes then start the fish counting on the same transect. At each 0.5 meter interval, 1 meter at each sites of the interval, indicator species were counted and recorded on the underwater recording paper.

2.3 Site observation/Underwater video camera

Description of the study sites from onsite observation and video camera were also carried out around the study areas at Tefisi.

2.4 SPSS – Suspended Particles in Sea Sediment

This method measures the weight of suspended particles in kg contained in one cubic meter of sea sediment to obtain the index of sediment of soil (silt).

This method involves 9 steps

1. sediment randomly sampling using plastic bag container from sites along the transect line
2. pretreatment – remove shells and small stones using sieve of 4mm mesh size
3. measuring – measure amount of sample (5 to 100ml) so that the transparency is obtained (5 to 30cm)
4. mess-up – put sample into 500 ml cylinder
5. shaking – shaking well so that particles are equally distributed

6. standing – leave for at least 1minutes
7. measuring transparency – pour samples into the 30cm transparency meter (turbidity tube) until black spot on the base of the meter are not seen and record
8. calculate content –

SPSS = (1718/T-17.8) X D/S

T = transparency
S = volume
D = rate of dilution

2.5 Indicators

Five indicators used for this study were:

1. % Coral coverage- percentage of coral coverage within the study area. The lower the percentage coverage of live coral indicating the effects of sedimendation.

2. Species indicators (Butterfly fish) Chaetodon spp – All butterfly fish are corallivores, feeding on corals, so no corals no butterfly fish

3. % epiphytes on seagrass – Epiphyte is a good indicator for pollution and sediment being added to the marine environment

4. Abundance of benthic organisms – Any marine environment with low abundance of marine benthos indicating pollution affecting the sites

5. SPSS value – The suspended particles in sea sediment measures the effects of sediment on corals and other marine benthos

2.6 Fish Count

Commercial fishes were recorded in a belt of 2 meters wide, 1 meter on each side of the tape.

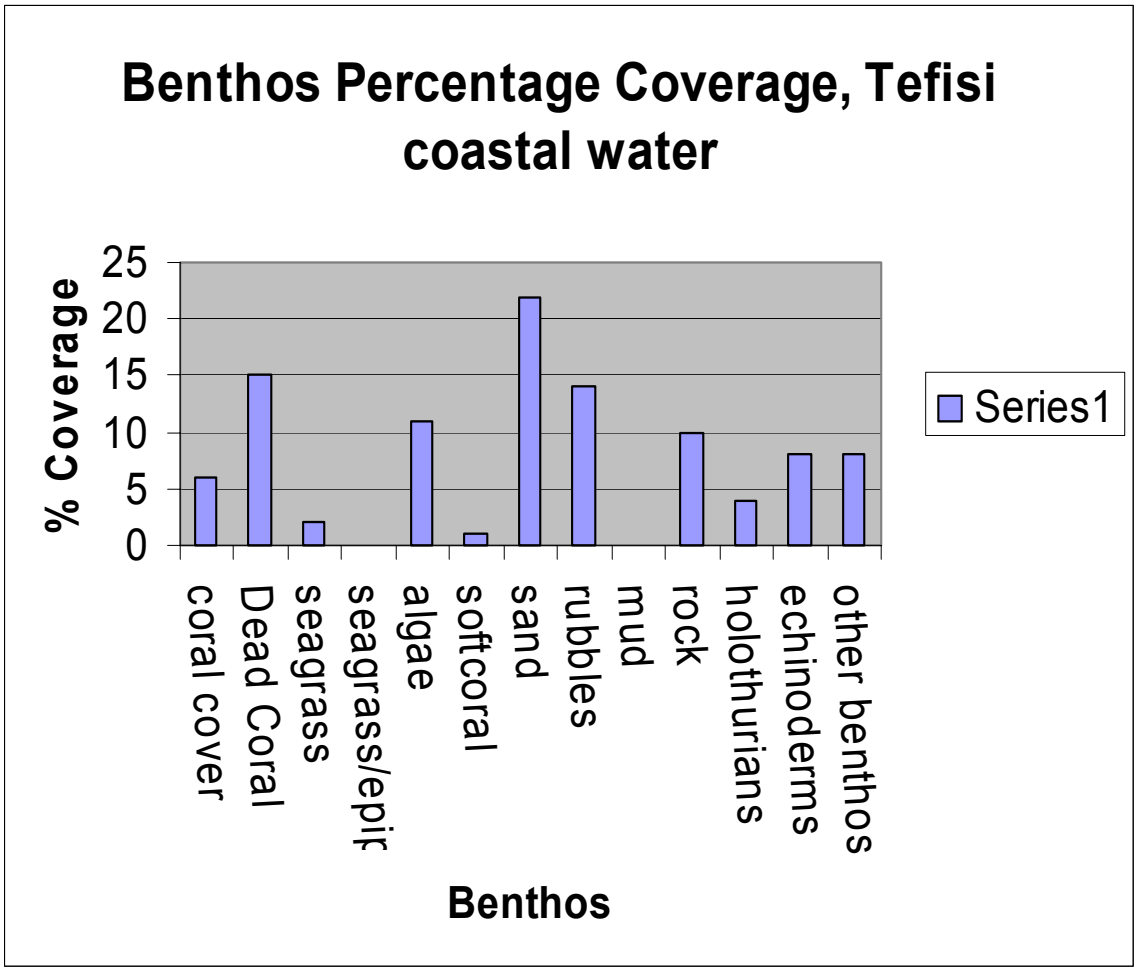
2.7 Data analysis

Data collected were analysed using spreadsheet for most of the graphing. No statistical analysis package was used.

3.0 Result

3.1 Survey Site 1

Graph 1: Percentage coverage of marine benthos and abiotic factors around the Tefisi coastal waters



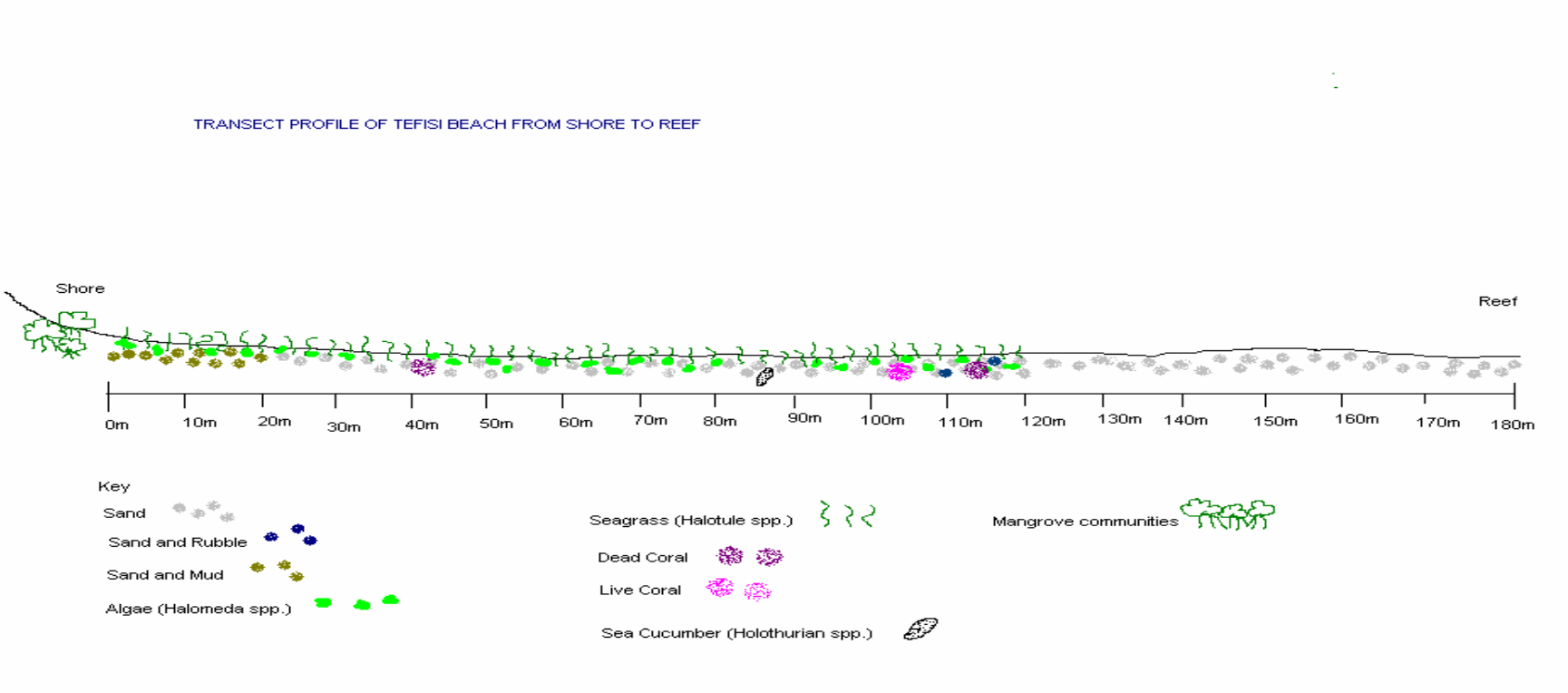
Graph 1 shows that live coral coverage is only 6%, which too low. Porities massive was the dominant coral species in the study areas. Abiotic resources dominated the area such as sand, rubbles, rocks and dead corals. Other marine organisms showed very low coverage.

Species Indicator (butterfly fish) *Chaetodon spp*

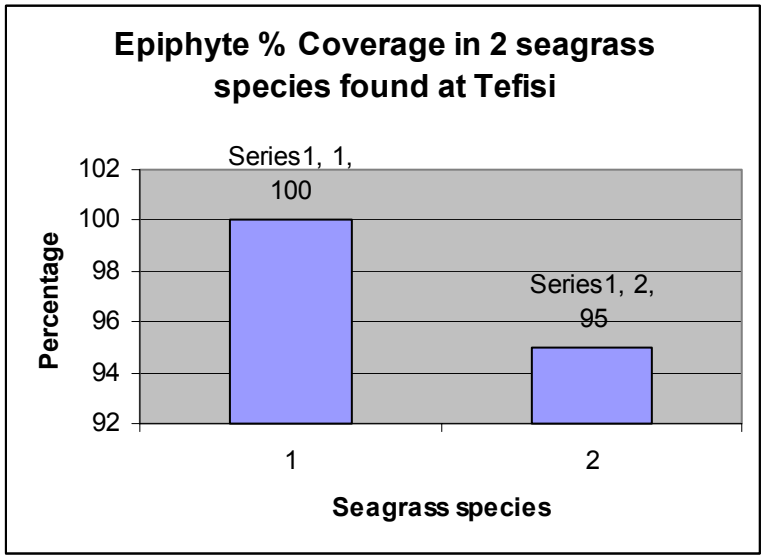
Five replicates in the study areas, no single *chaetodon spp* (butterfly fish) was counted. However, there were few small fishes of other families seen on each replicate but they not the species indicator.

Profile shows low abundance of marine benthic organisms

Figure 1 shows that over 60 % of the profile are mostly covered with sand and mud/soil, while the rest are mostly dense seagrass meadow (halodule and halophila spp). Algal species halimeda was also found in the areas. However, very few holothurians spp found on the transect, andno other life forms seen.

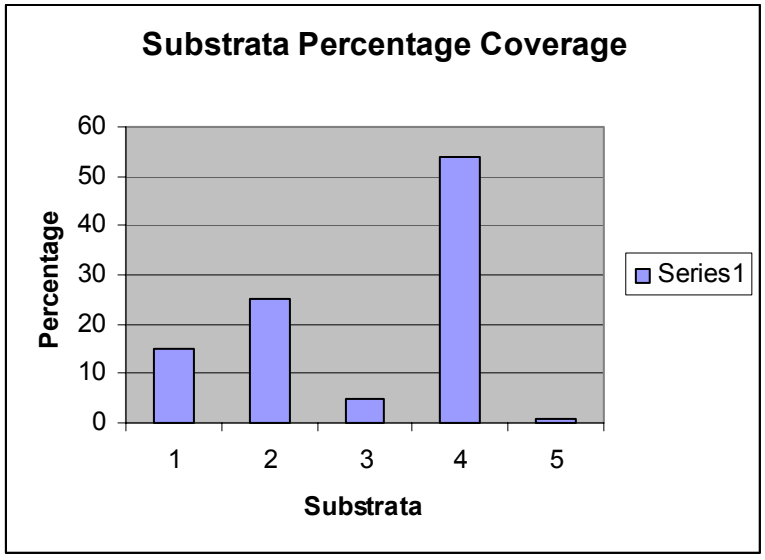


Graph 2: Percentage seagrass with epiphytes



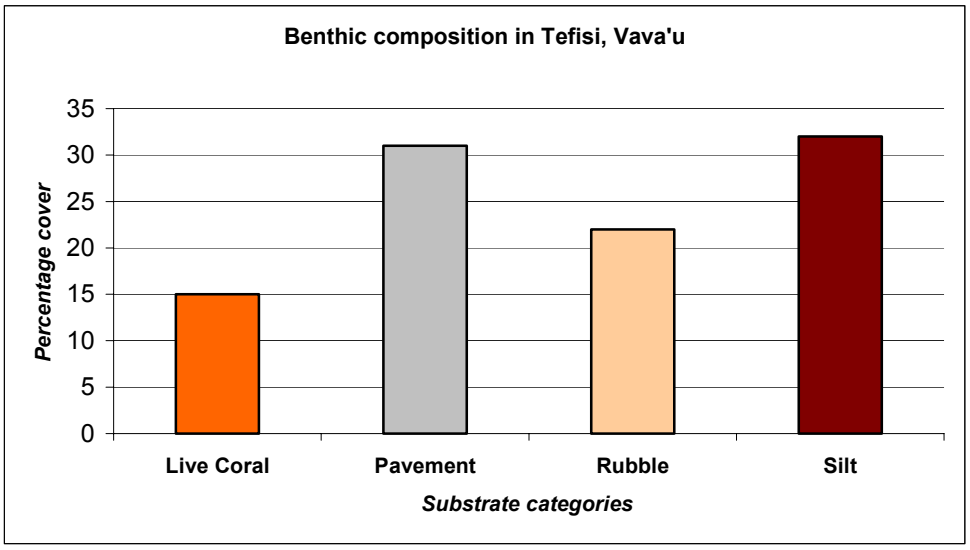
Graph 2 shows that the seagrass halodule spp (species 1) have 100% epiphytes, while the halophila spp (species 2) have 95 % coverage.

Graph 3: Substrata Percentage Coverage in the study area



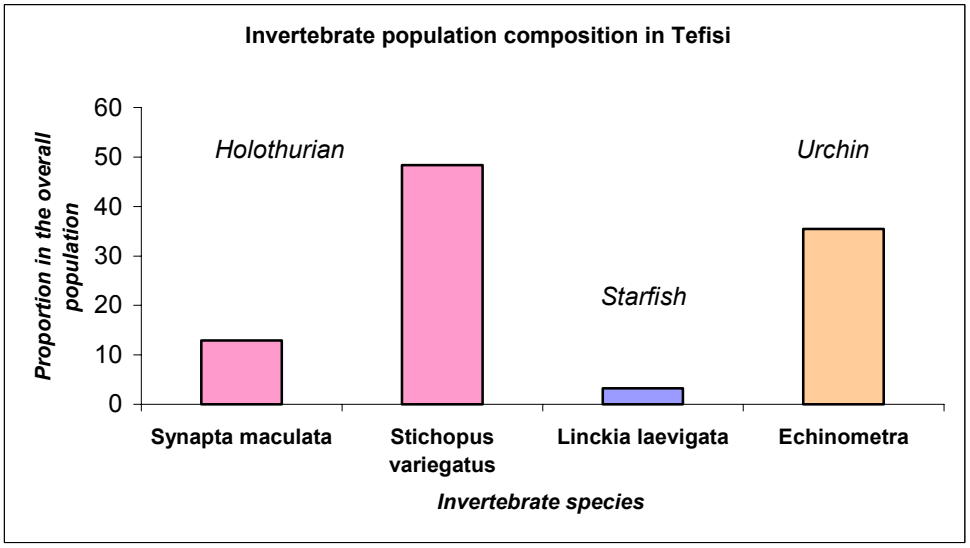
Graph 3 shows that the dominant substrata are mud/soil (substrata 4) with 54 % coverage ie close to the shore, and 150 meters to the edge. Rocks and rubbles are less than 5 %.

3.2 Survey Site 2



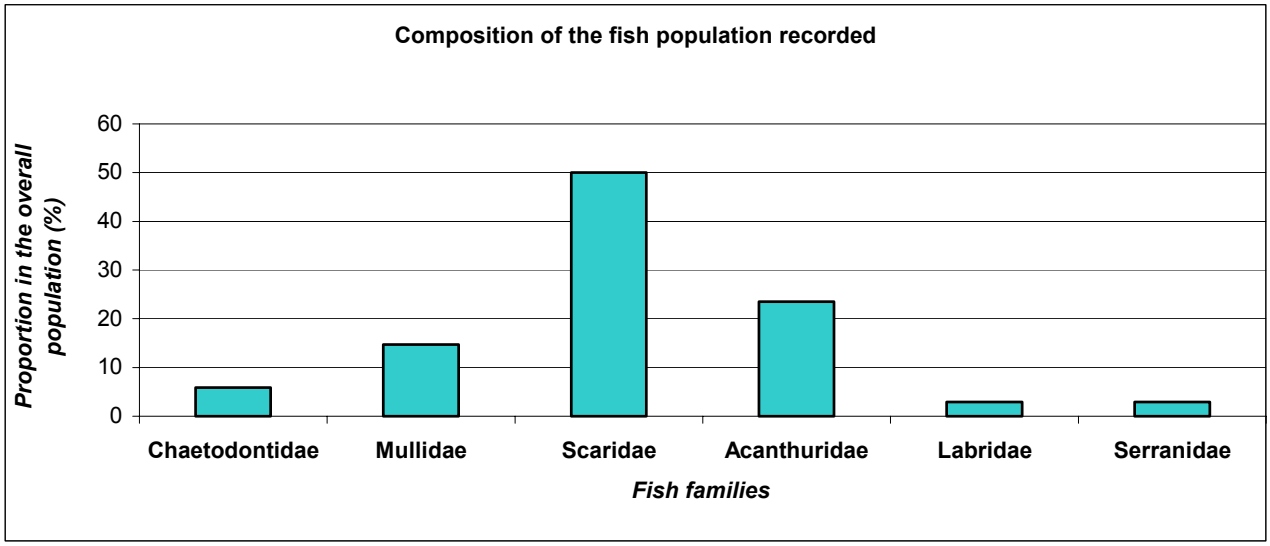
Graph 4: Benthic compostion in Tefisi, Vava'u

There is very few live coral in the site surveyed and the substrate is dominated by pavement, silt and rubble as a result of the proximity with the mangrove area. Water is generally cloudy and this does prevent corals from growing as well as the silt on the bottom where coral recruits have very few chance to develop.



Graph 5 : Invertebrate population composition in Tefisi

The invertebrate population is dominated by the holothurian *Stichopus variegatus*. This species is mostly found in sheltered sites receiving land inputs.



Graph 6 : Composition of the fish population recorded in Tefisi

Thirty four fishes have been recorded along the three transects. The three main families are parrot (Scaridae), surgeon (Acanthuridae) and goat (Mullidae) fishes. All the fishes observed were juveniles.

This information could be shared with local fishermen and they should be aware that this place is very likely to be a fish nursery and they should watch their catch sizes in order not to fish juveniles, and by doing this, not allowing them to reproduce before getting caught.

SPSS value high

SPSS value in kg/cubic meter

SPSS	0.4	1	5	10	50	200	400	>400
Category	1	2	3	4	5	6	7	8

Close to the edge i.e reef, the readings were around 60kg/cubic meter. According to the scale, they fall on gategory 5, which is corals can hard survive in this environment.

On the lagoon to shore readings were over 200kg/cubic meter. In accordance to the scale,they fall on gategory 6, 7, 8. In this gategory, no corals are grown.

Discussion/Conclusion

Low coral coverage

Low coral coverage in the study areas indicated that corals are adversely affected by the soil runoff. Soil sedimentation causes the water body to be more turbid, and thus block sunlight for corals to grow (photosynthesis). Smothering from runoff may also cause coral dead.

The only species that can withstand the effect of soil sedimentation is porities massive, and that is why few porities spp are found on the study areas.

High % epiphytes on seagrass

High % epiphytes on seagrass (halodule and halophila spp) are good indicators of an area being heavily polluted. Soil runoff from heavy rain brings foreign materials down to the coast and into the marine environment. Because, seagrass and algae do not have defensive mechanism to get rid of these matters

Abundance of marine benthos

Low marine organisms abundance in the study areas indicated that the areas are unhealthy and do not support life.

High % of mud/soil substrata

Substrata that often covers with mud/soil do not support many marine life especially those that are edible fishery.

Five indicators used for this study suggested that the marine resources in the Tefisi coastal water are degraded due predominantly to soil sedimentation from runoff. It is also important to consider the effects of over fishing and over harvesting of marine edible fisheries in the area.

This study also considers the mechanism causing the soil pollution at Tefisi coastal water. Soil pollution is often triggered by land development and other artificial factors. However, there are three primary natural factors leading to soil pollution. First is the quality of soil in the Tefisi region. Vava'u is the tropical region, and is fairly warm through the year animating the activity of the cultivating creatures and microorganisms within the soil. The resulting humus is extremely thin and easily dispersed by rainfall.

The geographical feature of Tefisi is considered to be the second natural factor. Tefisi is located on the western site of Vava'u, few 100 meters above sea level, creating a very steep slope down to the coast line. This will trigger and speed up the movement of water taking with them soil into the coastal environment.

Rainfall is the third natural factors contributing to soil runoff. The frequent rainfall coupled with high numbers of cyclones, storms, and strong wind in Vava'u contribute to the soil pollution.

Other environmental factors such as clearing of forest and coastal trees for development purposes are also considered in this context. Forest and coastal trees help prevent soil erosion or protect top soil from being wash away during heavy rain. Coastal forest such as mangrove helps stabalising sediments. However, at Tefisi clearing of forest and coastal trees are common practices there, especially for farming and other social needs.

Recommendations

1. **Coastal trees protection – no further destruction of coastal trees, and consider replanting mangroves and other important coastal vegetation.**

2. **Domestic animals protection such as pigs – Enforcing fencing of domestic animals such as pigs so that no further damages to the environment that may trigger soil erosion**

3. **Protection of forest – Encourage farmers of the important of conserving forest and trees for the prevention of soil erosion**

4. **Home fence – Encourage household to fence all town allotment to prevent soil exposure and erosion**

5. **Monitoring program in place – Inclusion of Tefisi coastal environment in the Department of Environment's monitoring program**

References

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2. Kaly et al. 2001. *Neiafu Harbour Areas Study*. Department of Environment, Tonga.

3. English E, Wilkinson c, Baker V. 1997. *Survey Manual For Tropical Marine Resources. 2nd Edition*. Australian Institute of Marine Science.

4. Veron J.E.N 1986. *Corals of Australia and the indo-Pacific*. University of Hawaii Press. Honolulu

Appendices

Table 1: Data recorded on the 3 transects set up in Tefisi

	Transect 1	**Transect 2**	**Transect 3**	**Total**
SUBSTRAT				
Live Coral				**19**
Porites	6	7	6	19
Pavement	14	9	15	38
Rubble	8	11	8	27
Silt	13	14	12	39
INVERTEBRATES				
Holothurian				**32**
Synapta maculata	1	2	1	4
Stichopus variegatus	4	6	5	15
Starfish				1
Linckia laevigata	0	1	0	1
Urchins				
Echinometra	0	0	11	11
FISH				**34**
Chaetodontidae	1	1		2
Mullidae	2	3		5
Scaridae		11	6	17
Acanthuridae		6	2	8
Labridae		1		1
Serranidae		1		1